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Football Helmet Technology Advancements and Their Implication During On-Field Management of The Potentially Spine Injured Athlete.


This paper was conceived to share important observations made during 15 years of sports emergency response training by Sports Medicine Concepts’ instructors that may help other sports health care professionals become better prepared to properly manage injured athletes in various types of equipment.

As football helmet and face mask fastener technology advances, certified athletic trainers are challenged to advance their psychomotor skills in order to continue to provide the highest level of care during on-field emergencies. It’s no longer good enough to practice equipment removal techniques. Sports medicine professionals must now practice these techniques on all the variations of football equipment that are found on today’s playing fields. Keeping up with all the advancements can be a daunting task. Here Sports Medicine Concepts, Inc., provides a brief overview of the leading helmet manufacturers and their recent history. In addition we provide a review of our experiences with the helmet during training sessions. The Manufacturer Information is taken directly from the manufacturers’ web sites and marketing materials while the SMC Field Notes come directly from our on-field experience with each helmet. It is not our intent to rate helmets with respect to concussion prevention or to provide suggestions for which helmets to use. It is our position that all of the helmets on the market have positive and negative attributes. In general, it is our position that getting the most out of the concussion prevention technology of any of these helmets depends mostly on a proper fit. Therefore, helmet recommendations may be best made based on the fit and comfort provided to an individual athlete.

Overall, none of the helmets presently on the market represent any significant hindrance to a sports medicine team’s on-field management goals. However, each helmet does have unique features that the sports medicine team must become familiar with. Sports medicine teams must take it upon themselves to practice with all the various protective athletic equipment in use in order to provide the most prudent care during unpredictable on-field emergencies.
Riddell Football Helmet Line-up

The Riddell Revolution football helmet, released in 2002, was the first major football helmet innovation in 25 years. Since 2002 Riddell has had on-going design changes to the Revolution helmet series, primarily to the internal padding and the face mask fasteners. Somewhere in the neighborhood of 2008 Riddell released the Speed helmet. Also at this time Riddell released the Revolution IQ helmet that features anterior and posterior Tru-Curve pads to improve fit and comfort. Most notably, Riddell introduced the Quick Release Face Mask Fasteners that are now standard side fasteners on the Revolution IQ and Speed helmets.

The Riddell Revolution football helmet - 2002

Manufacturer Information
Helmet contains z-pads, extended Tru-curve shell, and Isolator Faceguard System, Polycarbonate shell, Inflatable Back/neck/side liner, “No rust” stainless steel hardware, Built-in T-nut wrench, Inflation required, Standard forehead fasteners, Side rectangular fasteners with accessible cutting slots for facemask attachment

SMC Field Notes
The original side face mask fasteners made cutting the fasteners nearly impossible, but a second generation fastener with access slots for cutting devices replaced the first generation fasteners. There is now a third generation “race car” side fastener that features tapered ends for easier cutting. The only issue we faced with this helmet is the inconsistency in the side fasteners. Because there have been numerous variations to the side fasteners individual helmets may have different fasteners when returned from reconditioning. For helmets that have the second generation fastener with access slots, it is imperative to ensure that the fasteners are placed on the helmet correctly as the access slots are cut differently. The different orientation of the access slots can make fitting cutting blades to the fastener a bit tricky, especially if the fastener is not properly fit to the helmet. We suggest checking all Revolution helmets and replacing all fasteners with either the newest “race car” version or new Quick Release fastener (QR). The QR and “race car” fasteners are similarly shaped. The only difference is the “race care” version is screw fixed while the QR has the QR hardware. This helmet DOES NOT come standard with QR.

We have found no issues with this helmet with respect to on-field management. The helmet is removed as easily as any other helmet presently in use. The Zpads, or cheek pads, are fixed and cannot be removed, but we have not found ear pad removal to make removal of any football helmet any easier. Some suggest deflating the Z-pad prior to helmet removal, but again, we have not found this to facilitate removal of this helmet.
Riddell Revolution IQ football helmet
Manufacturer Information
Polycarbonate shell, SMART Design, Combining Riddell Revolution Concussion reduction technology, Ideal Fit Liner system with TruCurve back and front pads, (2) Quick release Face guard system for side fasteners of faceguard, Stainless steel hardware, Built in T-nut wrench, Mid-hookup softcup chin strap, (2) standard forehead loop fasteners

SMC Field Notes
This helmet comes standard with QR fasteners on the side. The QR fasteners make emergency face mask removal significantly easier, but the top fasteners still require a power screwdriver and back-up cutting device to ensure emergency airway access in the event of hardware failure. If the QR fastener hardware fails, the fastener will have to be cut; but the “race car” design allows easier access for cutting blades. We have come across incidences of QR hardware failure, but overall we find the fastener to be reliable and an asset to on-field management. Although this helmet boasts Tru-Curve back and front pads for an improved fit, we have not found these pads to negatively impact our ability to remove the helmet in an emergency scenario.

Riddell Revolution IQ HITS
Manufacturer Information
HITS- Head Impact Telemetry system, On-board electronics record every impact, Allowing players to upload and evaluate each occurrence on their home computers, HITS allows guidance necessary to understand and address suspect impact if it is detected, Available in Revolution IQ helmets, MX Encoder fits in stock helmet and records the location, magnitude, duration and direction of up to 100 impacts, Data downloads wirelessly to desktop or laptop, Includes 2 MX encoder battery packs and battery charging station.

SMC Field Notes
Adding the sensors to the IQ and implementing the monitoring system does not appear to have any effect on our ability to manage this helmet during an emergency.

Riddell Revolution SPEED football helmet
Manufacturer Information
Polycarbonate shell, Revolution Concussion Reduction Technology, Revo speed shell profile, Inflatable back/neck/side liner and crown liner, Stainless steel hardware, Built in T-nut wrench, Mid-high hookup softcup chin strap, (2) standard forehead loop fasteners, (2) Quick release Face guard system for side fasteners of faceguard.

SMC Field Notes
We have found no issue with this helmet with respect to on-field management. As always, the side quick release fasteners are a plus, but a backup cutter is required in the event of failure. The top fasteners still require a power screwdriver or cutter. The top fasteners do come in a thick and thin version to fit face masks with different circumferences, but this has no impact on emergency face mask removal.
The Riddell VSR-4 football helmet

Manufacturer Information
Polycarbonate shell, Inflatable liner with two outside inflation points, No rust stainless steel hardware, (4) standard loop fasteners for facemask attachment.

SMC Field Notes
Many believe that the completion of a number of on-going investigations will render this helmet style obsolete in the coming years. However, it is still standard issue for most football programs, particularly high school programs. The helmet poses no real threat to on-field management. The standard loop straps require a power screwdriver and cutter for face mask removal. The biggest issue with this style of helmet, independent of manufacture, is that a wide variety of face mask fasteners and face masks can be easily retro-fitted to the helmet. Sports health care professionals must be aware of all the various fasteners in use as well as the techniques used to cut them (See SMC’s Face Mask Removal Guide). We suggest an annual check of all helmets to ensure that you know what fasteners are being used. Standard loop straps for these helmets come in a thick and thin style to fit different face mask circumferences, but this poses no threats to on-field management.

Schutt Football Helmet Line-up

Schutt upgraded its helmet technology in 2003 with the release of the Schutt DNA helmet and Thermoplastic Urethane Cushioning. The following year Schutt released the Ion series. The most notable recent change to the Schutt line-up comes on the Ion series with the Energy Wedge Technology used to secure the face mask. In 2009 Schutt introduced Quarter Turn Release fasteners that come standard on the Ion 4D and Air XP Elite. The Quarter Turn Release fasteners can be retro-fitted to any helmet in the Schutt lineup, but helmets other than the 4D and Air XP Elite series will require boring the fasteners holes to fit the larger hardware.

The Schutt DNA Pro+ football helmet - 2003

Manufacturer Information
Two-piece SUREFIT inflatable air liner, The original TPU helmet, first introduced in 2003, now has the latest SKYDEX® cushioning system. Superior to traditional foam padding, TPU Cushioning features better impact absorption, better heat management and better hygienics. TPU Cushioning is highly resistant to mold, mildew, fungus and bacteria, while providing a barrier against MRSA and staph concerns. (4) standard loop fasteners for facemask attachment.

SMC Field Notes
We have not found any issues with this helmet with respect to on-field management. However, anecdotally, and we stress anecdotally, we are not comfortable with the shape of the helmet shell. Research indicates that the axial load mechanism causes approximately 52% of all cervical spine injuries in football. The target area for an axial load is approximately the forehead to the apex of the head. This helmet SEEMS to make that area more prevalent and susceptible to impact.
Schutt ION 4D football helmet

Manufacturer Information
Two-piece SUREFIT inflatable air liner system, Energy wedge technology acts as a shock absorber. Chin Strap attachment includes the Schutt short’n long or the 4-point high, Faceguard integrated into the shell of helmet, Energy wedge for side facemask attachment, Forehead facemask attachment with plastic plate with (2) standard screws or (2) Quarter Turn Release (QT) fasteners.

SMC Field Notes
The Energy Wedge system is often questioned by seminar participants. Some have expressed that the design interferes with the smooth shape of the helmet that helps a helmet deflect a blow. We have found no real issue with the Energy Wedge system with respect to on-field management. Earlier versions of Ion have a chin strap that was fed through a loop in the face mask, essentially securing the chin strap to the face mask. During face mask removal it is imperative to cut the chin strap PRIOR to face mask removal or significant movement of the head and neck will result from face mask removal. The 2009 versions of the Ion do not integrate the helmet and face mask, but many face masks still come with the loop that was intended for integration of the face mask. Therefore, check all helmets to ensure that newer helmets do not integrate the face mask and chin strap, and consider changing out older styles that do integrate the chin strap and face mask.

The top face mask retainer is a single piece with two integrated loop straps. Early versions of the face mask retainer had a back piece that was fixed INSIDE the helmet shell which necessitated cutting the face mask retainer. Second generation versions of the Ion top face mask retainer are mounted on the front of the helmet shell to permit either unscrewing or cutting.

The 2010 Ion 4D comes standard with Schutt’s new Quarter Turn Release (QTR) fasteners on the top of the helmet. This simplifies face mask removal considerably relative to earlier versions of the top fastener. However, be very diligent when ordering as we were shipped old inventory Ion 4D helmets without the QTR fasteners until we specifically asked for a helmet with the QTR fasteners. We were also shipped old inventory helmets using the early generation face mask retainers that would not allow us to cut the front face mask retainer. Schutt’s QTR fasteners will only fit helmets the 2010 Schutt Ion 4D and Air XP Elite series. All other Schutt helmets, including earlier versions of the Ion, require the helmets to be re-drilled to accept the QTR fasteners.

Schutt H.O.T. System football helmet

Manufacturer Information
H.O.T. system is an early warning detection system for heat stroke and other heat related injuries. Developed by HOTHEAD sports – a leader in heat monitoring technology. Sensor is the size of a dime and weighs less than an ounce, Sensor will fit inside any football helmet. Proprietary PDA can monitor hundreds of athletes within signal range, Sensor is weatherproof, Alert temperature can be customized for each player. When a player’s temperature spikes and doesn’t come back down, an audible and visual alert is sounded, with the intention of getting that player off the field before a serious, perhaps fatal, injury occurs.

SMC Field Notes
Integration of the technology has no effect on on-field management.
**Schutt Air XP football helmet**

*Manufacturer Information*

Traditional shell helmet, Two-piece SUREFIT inflatable air liner system, Six large ventilation holes in the crown of helmet, (4) standard loop fasteners for facemask attachment.

*SMC Field Notes*

Technology has no effect on on-field management. Helmet can be easily retrofitted with various face mask fasteners so check your players frequently so you know what fasteners you may encounter. Deflating bladders and liner, and removing cheek pads do not seem to facilitate removal.

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**Schutt Air Advantage football helmet**

*Manufacturer Information*

Helmet is 12% lighter than the Air XP, Unique airliner system, Large ventilation holes on the crown, Features a third chinstrap snap location, AIR padding system, (4) standard loop fasteners for facemask attachment.

*SMC Field Notes*

Technology has no effect on on-field management. Helmet can be easily retrofitted with various face mask fasteners so check your players frequently so you know what fasteners you may encounter. Deflating bladders and liner, and removing cheek pads do not seem to facilitate removal.

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**Schutt AIR standard football helmet**

*Manufacturer Information*

Lightweight ABS resin shell, Vinyl-nitrile foam and a comfort fit liner, SUREFIT slots accommodate inside-fitting chin straps, (4) standard loop fasteners for facemask attachment.

*SMC Field Notes*

Many believe that the completion of a number of on-going investigations will render this helmet style obsolete in the coming years. However, it is still standard issue for most football programs, particularly high school programs. The helmet poses no real threat to on-field management. The standard loop straps require a power screwdriver and cutter for face mask removal. The biggest issue with this style of helmet, independent of manufacture, is that a wide variety of face mask fasteners and face masks can be easily retro-fitted to the helmet. Sports health care professionals must be aware of all the various fasteners in use as well as the techniques used to cut them (See SMC’s Face Mask Removal Guide). We suggest an annual check of all helmets to ensure that you know what fasteners are being used. Standard loop straps for these helmets come in a thick and thin style to fit different face mask circumferences, but this poses no threats to on-field management.
Xenith X1 Football Helmet

Xenith introduced the X1 helmet in 2004 after five years of technology development, using an integrated approach to address concerns from coaches, parents, and healthcare professionals regarding the high incident rates of sports related concussion. Most distinguishable features of the X1 are the shock absorbers, flexible bonnet, and chin piece. The X1 shock absorber system is comprised of eighteen 2-inch-diameter hollow thermoplastic pucks, each with a small hole for airflow. With contact each shock absorber flattens and reinflates in 0.003 seconds. Each of the shock absorbers is fixed in a flexible bonnet that is comprised of a pulley system with a drawstring and straps that cinch this bonnet to a player’s head for a custom fit. The bonnet is automatically fitted when a player attaches the chin piece that houses the pulley for the bonnet's drawstring and straps.

Also unique to Xenith is the company’s web site support and emphasis on education as a cornerstone to successfully addressing the issue of sports related concussions in football. Xenith’s web site is home to the Xenith Academy, dedicated to player, coach, and parent education.

**XENITH X1 football helmet – 2004**
**Manufacturer Information**
Polycarbonate shell, (18) Aware FLOW shock absorbers, Thermoplastic polyurethane, Shock bonnet adapts to magnitude and direction of hit, FIT seeker cable creates an instant snug fit, Stainless steel hardware, (4) standard loop fasteners for facemask attachment, Four snap Chin Cup-Impact absorbing system.

**SMC Field Notes**
*Many raise eyebrows when we show the features of this helmet. Some have concerns with the bonnet system. Specifically, there are concerns that the integrated chin strap and bonnet will result in movement of the head and neck within the helmet when the chin strap is cut during on-field management. During our experience, this does not happen. The helmet poses no real challenges to on-field management and is as easily removed from a player as any other helmet available. The helmet comes standard with loop strap fasteners, but could be retro-fitted with any of the various face mask fasteners available. Be sure to check to see what is being used by your athletes.*
ADAMS Football Helmet Line-up

ADAMS A-4 football helmet

Manufacturer Information
Polycarbonate shell, Expanded Polypropylene Liner, Energy dispersement ridge, Stainless steel hardware, (4) standard loop fasteners for facemask attachment

SMC Field Notes
Technology has no effect on on-field management. Helmet can be easily retrofitted with various face mask fasteners so check your players frequently so you know what fasteners you may encounter. Deflating bladders and liner, and removing cheek pads do not seem to facilitate removal. This particular helmet is a youth only helmet.

ADAMS Pro-Elite Helmet A2000 football helmet

Manufacturer Information
Polycarbonate shell, Energy dispersement ridge, Rear helmet shell offset, EVA liner and Front EVA liner- provides comfortable fit and energy management, Custom Air liner with left rear inflation Air port, Stainless steel hardware, (4) standard loop fasteners for facemask attachment

SMC Field Notes
Technology has no effect on on-field management. Helmet can be easily retrofitted with various face mask fasteners so check your players frequently so you know what fasteners you may encounter. Deflating bladders and liner, and removing cheek pads do not seem to facilitate removal.

Nokona Football Helmet Line

Nokona NH60 Football Helmet

Manufacturer Information
Dual-density circumference padding system with a cross-link crown liner, Backed up with high-density vinyl nitrile inserts with triple-layer vinyl coating. High-density polyethylene shell offers maximum durability and light weight. Designed with youth/recreation leagues in mind, this helmet system offers ease of fitting and maximum wear capability at an economical price.

SMC Field Notes
Technology has no effect on on-field management. Helmet can be easily retrofitted with various face mask fasteners so check your players frequently so you know what fasteners you may encounter. Deflating bladders and liner, and removing cheek pads do not seem to facilitate removal. This is a youth only helmet.