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Observations Relating to Possible Complications and Suggested Management Consideration For Care of the Critically Injured Football Player Wearing the Riddell SpeedFlex, Schutt Vengeance VTD II, and Xenith Epic Football Helmets.

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Disclaimer: The author has a financial interest in the FMxtractor®, a device used in the removal of facemasks from football helmets, and the In 2Minutes or Less!® sports emergency care training curriculum. All helmets reviewed in this article were purchased from the manufacturer by Sports Medicine Concepts.

As football equipment design changes continue at a breakneck pace, sports medicine teams are challenged to advance their cognitive knowledge of how these design changes might impact completion of critical care tasks during on-field emergency management, and to develop appropriate psychomotor skills to ensure efficient completion of critical care tasks for players wearing this equipment. It is no longer good enough to simply practice football equipment removal techniques. Sports medicine teams must practice completion of critical care tasks under a multitude of varying conditions, some of which may be affected by the type of football helmet an athlete is wearing. This article is intended to provide sports health care professionals with an overview of clinical instructor observations relating to potential barriers that three new football helmets may have on completion of critical care tasks during sports emergency care simulation training. The observations presented in this article are those associated with the barriers to maintaining cervical neutral alignment during repositioning and transfer, performance of high-quality CPR, facemask removal, and helmet removal as identified by medical professionals during live simulation training. The information presented in this article is purely anecdotal and represents the expert opinion of the author based on observations made during live simulation training provided to multi-disciplined medical professionals. Sports health care professionals should not use these observations to make changes to existing protocols, but should use the observations to initiate discussions aimed at developing skill practice scenarios. It is not the intent of this article to recommend any helmet, service or product that may be mentioned, to suggest that any one helmet, service, or product is better or safer than any other, to affirm or disprove any manufacturer claims, or to suggest the effectiveness or appropriateness of any particular technique, protocol, helmet, service, or product.

Each section of this article begins with an overview of a specific helmet's design features and technology. The information contained in the overview was taken directly from the respective manufacturer's web site. Each helmet was then used during live simulation training during delivery of Sports Medicine Concepts' In 2 Minutes or Less!® sports emergency care training curriculum. Each helmet was anecdotally assessed over 12 training sessions delivered throughout the United States during the summer of 2015. Participants included athletic trainers, trauma physicians, team physicians, airway management physicians, and paramedics practicing in the professional, collegiate, and high school settings. The observations noted here only reflect conditions during which the helmet produced a consistent noteworthy barrier to participants' ability to complete critical care tasks relating to maintaining neutral cervical position during repositioning and transfer, delivery of high-quality CPR, facemask removal, and helmet removal using the techniques outlined in this article to complete live simulation exercises. After reviewing this article, readers should be able to:

1. Explain the important design and technological features of each discussed helmet;
2. Organize practice sessions to assess the observational information presented in this article;
3. Collaborate with peers to develop solutions to barriers to the completion of critical care tasks identified in this article.

The specific techniques outlined below were used during assessment of the football helmets described in this article.

3-Person Log-Roll Repositioning Technique Used

Most athletic trainers felt they would need to reposition an injured athlete prior to the arrival of EMS using only the help of coaches. Therefore, a 3-person flat-logroll technique was chosen to more accurately reflect the conditions under which most athletic trainers felt they would have to complete a logroll maneuver in real practice.

A-Man: at athlete's head

1. Maintains immobilization of the athlete's head and neck;
2. Prepare to logroll the patient in the direction opposite the patient's face by assuming a start position with the A-Man's inside knee positioned at the patient's lower shoulder;
3. Place hands on head/helmet with the palms together and thumbs down, and the arm corresponding to the direction of the log roll on top, such that the A-Man's arms are twisted at initiation of the log roll and untwist during completion of the maneuver;
4. Directs the log roll maneuver;
5. Watches the torso turn and maintains neutral in-line support of the head, rotating it exactly with the torso;
6. Positions the patient in cervical neutral position and directs B- and C-Man to pack-n-fill any void between the back of the helmet and the ground as required to preserve cervical neutral position.

Step 1

1. B-Man kneels at the patient's mid-torso, straightens the patient's arms with the patient's palms facing in next to the torso;
2. B-Man then grasps the far side of the patient at the shoulder and just above the elbow;
3. C-Man kneels next to B-Man and grasps the patient's pelvic bone;
4. C-Man's lower hand grasps at the ankles.
5. C-Man places their lower foot up against the patient's legs, just below the knees for the patient's lower legs to roll onto during the log roll, to prevent the patient's pelvis from drooping;

Step 2

1. Under the direction of the A-Man, the patient is carefully log rolled until perpendicular to the ground;
2. A-Man watches the patient's torso turn and maintains manual support of the head, rotating it exactly with the torso;
3. C-Man at the patient's legs assists with rotation of the patient's torso and takes the weight of the patient's pelvis, again watching the torso. The patient's lower legs roll onto B-Man's lower foot to prevent pelvic drooping.

Step 3

1. Under the direction of the A-Man, B- and C- Man reposition themselves to provide sufficient clearance for the athlete to smoothly transitioned from the perpendicular to supine position;
2. A-Man positions the athlete in cervical neutral position and calls for B- and C-Man to pack-n-fill any voids between the athlete's helmet and the ground.

5-Person Flat-Logroll-Push Transfer Technique

Most athletic trainers felt they would not transfer an injured athlete to rigid support until EMS arrived. Therefore, a 5-person flat-logroll-push technique was chosen to more accurately reflect the conditions under which most athletic trainers felt they would have to complete the transfer technique in real practice. The flat-logroll-push technique was chosen because most multi-disciplined medical teams preferred the technique over other variations of the logroll maneuver after rehearsing with each.

A-Man: at athlete's head

1. Maintains immobilization of the athlete's head and neck;
2. Prepare to logroll the patient in the direction opposite the patient's face by assuming a start position with the A-Man's inside knee positioned at the patient's lower shoulder;
3. Place hands on head/helmet with the palms together and thumbs down, and the arm corresponding to the direction of the log roll on top such that the A-Man's arms are twisted at initiation of the log roll and untwist during the maneuver;
4. Maintain manual head stabilization until full immobilization to the long spine board (LSB) is achieved;
5. Directs the log roll maneuver;

6. Watches the torso turn and maintains neutral in-line support of the head, rotating it exactly with the torso;
7. Positions the patient in cervical neutral position and directs B- and C-Man to pack-n-fill as required to maintain proper neutral position.

Step 1

6. B- and C-Man clear the area of any extraneous objects or medical equipment;
7. If the protective athletic equipment remains in place, B- and C-Man utilize pack-n-fill towels to maintain cervical neutral alignment;
8. If the protective athletic equipment has been removed, B- will apply a c-collar on the patient and provide pack-n-fill padding as required to support cervical neutral position;
9. B-Man kneels at the patient's mid-torso, straightens the patient's arms with the patient's palms facing in next to the torso;
10. B-Man then grasps the far side of the patient at the shoulder and just above the elbow;
11. C-Man kneels next to B-Man and grasps the patient's pelvic bone;
12. C-Man's lower hand grasps at the ankles.
13. C-Man places their lower foot up against the patient's legs, just below the knees for the patient's lower legs to roll onto during the log roll, to prevent the patient's pelvis from drooping;
14. D-Man kneels on the opposite side of the patient at the patient's pelvic level;
15. D-Man's upper hand is placed on the patient's upper arm and the lower hand is placed on the patient's upper leg.
16. D-Man provides support and control of the logroll from the side opposite B- and C-Man.

Step 2

4. Under the direction of the A-Man, the patient is carefully log rolled until at a right angle to the ground;
5. A-Man watches the patient's torso turn and maintains manual support of the head, rotating it exactly with the torso;
6. C-Man at the patient's legs assists with rotation of the patient's torso and takes the weight of the patient's pelvis, again watching the torso. The patient's lower legs roll onto B-Man's lower foot to prevent pelvic drooping.

Step 3: E-Man slides the LSB in against the ground with the edge of the LSB towards the patient's back. Align the patient's shoulders level with the shoulder markings on the LSB.

Step 4: Lower the patient onto the LSB, again with A-Man setting the pace.

Step 5: Keeping the patient in the neutral in-line position, use a v-slide to gently adjust the patient's position sideways so that the patient is centered on the LSB.

Step 6: Apply appropriate padding under the patient's head and lumbar spine to maintain proper alignment of the spinal column and for comfort;

Step 7: Immobilize the patient onto the LSB for transport.

Facemask Removal Technique

A multi-faceted approach to facemask removal was used during assessment of these helmets. Facemask removal was first attempted using a power screwdriver for helmets using a screw and t-nut attachment. When a proprietary facemask attachment system was used on a helmet, these systems were engaged according to manufacturer recommendations during initial facemask removal attempts. Instructions for engaging the Riddell Quarter-Turn facemask attachment system can be found at www.Riddell.com. Instructions for engaging the Schutt Quarter-Turn facemask attachment system can be found at www.Schuttsports.com.

In the event that the power screwdriver or proprietary facemask attachment system failed to release the facemask, a back-up cutting device was employed to cut the facemask attachment system fasteners. Facemask removal failure was defined as the inability of the sports medicine team to deliver the rescue breaths within the first two cycles of CPR due to ongoing interference from the facemask. During these observations the end-effectors on the model 3 FMxtractor® (FMx3) were used to engage the quick-release and quarter-turn attachment systems, and as the back-up cutting device to cut the facemask attachment system fasteners when the power screwdriver or proprietary systems failed. The specific facemask removal techniques, including use of the power screwdriver, quick-release, quarter-turn, and FMxtractor® cutting techniques used during these

observations can be found at www.SportsMedicineConcepts.com.

A-Man

- Maintain in-line stabilization, being sure to hold in-line stabilization with enough force to counteract external forces resulting from face mask removal procedures;

B- and C-Man

- Initiate facemask removal on their respective sides using a power screwdriver, FMextractor® end-effector, or quick-release tool;
- In the event of hardware system failure, use the FMx3 to cut the face mask fasteners to release the face mask from the helmet.

Helmet Removal Technique

When it is determined that the football helmet and shoulder pads should be removed from an athlete, the following removal procedure was be followed:

1. The A-Man shall maintain in-line stabilization of the head and neck;
2. The B- and/or C-Man shall prepare the helmet for removal by cutting the chin-strap and removing the mouth guard.
3. The B- or C-Man shall take control of and maintain in-line stabilization of the athlete's head and neck by reaching in from the side to wrap hands around the neck such that the thumbs run along the mandible, coming to rest at the temporal-mandibular joint, while the fingers interlock to support the cervical spine posteriorly.
4. Upon securing in-line stabilization B- or C-Man shall iterate to the A-Man that they have sufficient control of in-line stabilization, upon which the B- or C-Man shall count "1-2-3, Release" to officially take control of the in-line stabilization from the A-Man.
5. The A-Man will begin the helmet removal process by first removing all pack-n-fill towels used to maintain cervical neutral position;
6. The A-Man will then begin helmet removal by slightly spreading the helmet at the earholes, then will carefully begin pulling the helmet from the athlete until the athlete's ears are just about to clear the helmet cheek pads, at which point the A-Man shall pause helmet removal;
7. The A-Man shall next iterate to the team member providing stabilization that the athlete's ear are about to clear the helmet cheek pads and that helmet removal will resume on the count of "1-2-3, Remove". This allows the team member providing in-line stabilization ample time to prepare to mediate a rebound force often observed to cause significant movement of the cervical spine when the helmet cheek pads slide over the athlete's ears during football helmet removal. Upon the "1-2-3, Remove" command, the A-Man shall resume extraction of the helmet by pulling the helmet while tipping the helmet slightly forward to clear the occiput posteriorly, but being careful to not hit the athlete's nose when the face mask is still in place.
8. Once the football helmet has been removed the A-Man shall pack-n-fill the athlete in cervical neutral position and then retake control of in-line stabilization.
9. The A-Man shall iterate to the team member presently maintaining in-line stabilization that they are properly positioned and are ready to re-take control of in-line stabilization, at which time the A-Man shall count "1-2-3, Release". The A-Man shall now have control of in-line stabilization.



Riddell SpeedFlex Helmet Overview

Riddell's goal with the SpeedFlex[®] helmet is to reduce impact force transfer by designing a helmet that combines flexibility in the shell, face mask, and face mask attachments with composite energy management through a strategic combination of padding materials that absorb impact energy (www.Riddell.com).



The SpeedFlex[®] utilizes an All-Points Quick Release[®] (QR) face mask attachment system that incorporates precision-milled stainless steel hardware that is designed to make face mask removal quicker and easier by disengaging the face mask by pushing a button within the push-pin housing. A Tru-Curve[®] 5-point custom inflation liner system conforms to the shape of a player's head while fitting the contours of the helmet shell, using strategically placed crown, back/side, occipital lock, face frame (jaw), and front padding. The Occipital Lock[®] is an inflation point within the liner that, when inflated, cradles the athlete's occipital lobe, improving the helmet's security and fit. Riddell's Patented Side Impact Protection[®] (PSIP) is research-based, mandible protection that is designed to reduce the force from side impacts. PSIP consists of side shell extensions

combined with side liner extensions. A Ratchet-Loc Retention[®] chinstrap attachment system provides for helmet adjustments. A high strength spring stainless steel face mask is thinner and lighter than other face masks.

SMC Field Note Observations

Maintaining Cervical Neutral Alignment

When fitted according to manufacturer instructions, the Tru-Curve[®] 5-point custom inflation padding and liner of the SpeedFlex[®] creates a snug fit that results in the helmet being an asset during efforts to maintain stabilization of the head and neck during and following repositioning and transfer activities.

High Quality CPR

Initial attempts to perform a modified jaw thrust maneuver (MJT) to open the airway and assess the athlete's breathing status are routinely complicated by the PSIP of the SpeedFlex[®]. Specifically, the mandibular shell extensions combined with properly inflated face frame pads prevents proper rescuer hand placement and the ability to draw the mandible forward during attempts to perform the MJT. More aggressive attempts to secure proper MJT hand position results in considerable movement about the head and neck. The face frame pads are secured to the helmet shell and are not removable.

To secure proper hand placement and complete the MJT in athlete's wearing the SpeedFlex[®], sports medicine teams may consider the following observations:

1. In some instances deflating the face frame pads using a standard inflation needle provided enough space to allow rescuers with smaller hands to secure proper hand positioning, but drawing the mandible forward continued to be a challenge.
2. Removing the face mask from the helmet results in the ability to better spread the mandibular extensions and secure proper rescuer hand position. Drawing the mandible forward to complete the MJT was easier, though still not optimal.
3. Removing the helmet from the athlete provided for optimal hand placement and completion of the MJT.

None of the options presented above were found to be successful or most appropriate consistently enough to warrant them becoming a protocol suggestion for the emergency management of athlete's wearing the SpeedFlex[®]. The prudent sports medicine team will be prepared to complete specific critical care management techniques when deemed most appropriate by a sports medicine team considering the primary objective of critical care at any given moment.

In some instances, sports medicine team personnel participating in simulation training have found it appropriate to retract the face mask to gain access to an injured athlete's airway by releasing the two lateral face mask attachments and retracting the facemask about the two forehead face mask attachments. Careful

handling during this process with other helmets does not seem to result in significant observable movement at the head and neck, but this option is not available with the SpeedFlex® as the position of the face mask attachments do not permit the face mask to retract. It should be noted, that sports medicine teams that elect to perform face mask retraction do so to more rapidly secure a patent airway in a non-breathing athlete. After securing a patent airway, the sports medicine team should plan for expedited face mask extraction to avoid the retracted face mask interfering with on-going completion of critical care tasks.

Facemask Removal

Historically, sports medicine team participants participating in live simulation training have found Riddell's QR hardware to be inconsistent and more challenging than the name would suggest. The SpeedFlex® QR attachment system does provide rapid and efficient face mask removal, but it is more impressive when practicing on a lab bench during demonstrations that it is during live simulation training on a fully outfitted supine football player. During live simulation training, the QR attachment system occasionally fails because simply pushing the button on the push-pin using the Riddell QR Tool or the FMx3® QR End-Effector fails to disengage the system without significant effort and multiple attempts. Participants also find accessing the inferior attachment push-pin buttons using the Riddell QR Tool or the FMx3® End-Effector challenging in the supine athlete in full protective gear. Access to the push-pin buttons appears to be easier with the FMx3® QR End-Effector, but the system still fails to disengage more often than the name would suggest it should. In the event that the face mask attachments must be cut, the FMx3® two-cut technique was found optimal on all of the SpeedFlex® facemask attachments.

There is risk of failure in all mechanical systems. Therefore, the prudent sports medicine team will not rely on any one approach to ensure the ability to complete critical care tasks during unpredictable on-field emergency management.

Helmet Removal

The SpeedFlex® might seem like it would be more challenging to remove than other helmets, but this does not appear to be the case. When properly fitted according to manufacturer guidelines and using the protocols outlined above, the SpeedFlex® is removed as easy as any other football helmet. The more significant chinstrap design did take a little more effort to cut prior to helmet removal, but nothing that a good pair of trauma shears won't handle. Participants compared removing the SpeedFlex® under various conditions, including removing the helmet with a normal fit, after having deflated the 5-point Tru-Curve® pads, and following face mask removal. Helmet removal following face mask removal may be easier, but, in general, the helmet was removed under each condition without any anecdotally reported complications or with any observable difference in motion about the head and neck.

Schutt Vengeance VTD II



The Vengeance VTD II[®] is the newest generation Variable Thickness and Durometer (VTD) helmet from Schutt Sports. The Thermoplastic Urethane[™] (TPU) Cushioning contains durometers that are specifically designed to absorb both high-velocity and low-velocity impacts.

The VTD II shell features Schutt's patented Flexural Resistance Back Shelf[™] that was designed to increase strength and impact absorption in the back of the helmet. The Vengeance line of facemasks offers an offset eyebrow design which claims to increase impact absorption. Schutt's patented Twist Release[®] System secures the face mask to the forehead of the helmet while two traditional loop strap facemask fasteners attach the facemask to the helmet laterally using a screw and t-nut. The VTD II integrates a single TPU layer to improve impact absorption while reducing overall weight, and a dual TPU layer in the helmet's front. The TPU layer is mechanically attached to the helmet shell to hold it securely in place. The VTD II utilizes Schutt's SUREFIT TPU AiR Liner[™] that has a TPU outer skin with increased surface coverage to make the helmet more comfortable. Beneath the TPU outer skin, additional comfort foam creates a dynamic fit and long-lasting durability. The AiR Liner[™] also features high impact foam in the front cushion to add an additional layer of protection.

SMC Field Note Observations

Maintaining Cervical Neutral Alignment

When fitted according to manufacturer instructions, the VTD II Surefit TPU AiR liner[™] creates a snug fit that results in the helmet being an asset during efforts to maintain stabilization of the head and neck during and following repositioning and transfer activities.

High Quality CPR

Initial attempts to perform a modified jaw thrust maneuver (MJT) to open the airway and assess the athlete's breathing status are routinely complicated by the VTD II. Specifically, the snug fit of the TPU cheek pads make drawing the mandible forward during attempts to perform the MJT.

To facilitate completion of a MJT in athletes wearing the VTD II, sports medicine teams may consider the following observations:

1. Removing the TPU cheek pads to permit the mandible to be drawn forward. Although successful, this technique may not be optimal as removing the TPU cheek pads is challenging, time consuming, and results in observable movement about the head and neck.
2. Removing the face mask from the helmet results in the ability to better spread the helmet shell, making the MJT easier with the TPU cheek pads in place. Facemask removal also makes cheek pad removal easier. After TPU cheek pad removal, completion of the MJT was uncomplicated. However, facemask and TPU cheek pad removal is time consuming and may not be practical in critical circumstances.
3. Removing the helmet from the athlete results in effective completion of the MJT.

None of the options presented above were found to be successful or most appropriate consistently enough to warrant them becoming a protocol suggestion for the emergency management of athlete's wearing the VTD II. The prudent sports medicine team will be prepared to complete specific critical care management techniques when deemed most appropriate by a sports medicine team considering the primary objective of critical care at any given moment.

Facemask Removal

The lateral facemask fasteners of the VTD II are generally easy to remove using a power screwdriver. Occasional hardware failure was observed, but the lateral fasteners were easily cut using any of the FMx3 techniques identified for use on traditional loop strap style fasteners. Once the lateral fasteners were released the facemask is easily retracted and twisted right or left to release it from the Twist Release forehead facemask retainer. There was never an instance when the Twist Release[™] fastener failed to release the facemask.

However, participants used the FMx3[®] to cut the Twist Release fastener just to be sure. The Twist Release retainer was easily cut using the FMx3[®].

Most interesting with this helmet with respect to facemask removal is Schutt's use of fixed screws and t-nuts rather than its Quarter-Turn Release (QT) facemask attachment system. The QT attachment system is an option on other Schutt helmets, including the ION 4D[™], AiR XP Elite[™], and DNA Pro+ Elite[™]; but not on the company's most technologically evolved design. During recent years of training that have included the QT attachment system on other Schutt helmets there has not been a single observed failure of the QT attachment system during live simulation training.

For observational purposes only SMC instructors retrofitted the VTD II with the QT attachment system laterally, leaving the standard Twist Release[™] facemask retainer to secure the facemask to the forehead. This required boring the hardware hole on the sides of the helmet to fit the QT hardware. During live simulation sports medicine teams were consistently able to extract the face mask from the retrofitted VTD II in 8-12 seconds, with minimal effort, and without a single observed failure.

There is risk of failure in all mechanical systems. Therefore, the prudent sports medicine team will not rely on any one approach to ensure the ability to complete critical care tasks during unpredictable on-field emergency management.

Helmet Removal

When properly fitted according to manufacturer guidelines and in accordance with the technique outline above, the Schutt VTD II is removed as easy as any other football helmet. Participants compared removing the VTD II under various conditions, including removing the helmet with a normal fit, after having removed the TPU cheek pads, and following face mask removal. Helmet removal following face mask removal may be easier, but, in general, the helmet was removed under each condition without any anecdotally reported complications or with any observable difference in motion about the head and neck.

Xenith Epic



The Xenith Epic™ football helmet features Xenith's Adaptive Head Protection (AHP). AHP is a system of patented technologies - including the company's Shock Bonnet® protective liner, Aware-Flow® Shock Absorbers and Fit Seeker® systems -designed to provide superior fit and to minimize the sudden movement of the head during impact. The polycarbonate shell of the Epic is designed for high level impacts. The face mask is attached to the helmet via 4 traditional loop straps secured using screws and t-nuts.

The Shock Bonnet compression liner acts as a suspension system, keeping the head secure and allowing the shell to move independently to help dissipate force. The Aware-Flow® shock absorbers utilize multi-staged compression to attenuate impact energy, offering increasing levels of resistance to adapt to low, medium, and high impacts. The interior ridge adds 2 additional walls to the original shock absorber design, creating a more reinforced structure to enhance its ability to minimize sudden head movement.

The Fit Seeker® system features a FitLock® pad engineered from high quality injected foam for superior fit and comfort while securing the helmet to the occipital bone for the ultimate in fit and retention. The integrated chin strap system pulls the Shock Bonnet around the head to provide a more custom fit.

SMC Field Note Observations

Maintaining Cervical Neutral Alignment

When fitted according to manufacturer instructions, the Epic Shock Bonnet® creates a snug fit that results in the helmet being an asset during efforts to maintain stabilization of the head and neck during and following repositioning and transfer activities. Some participants expressed a fear that cutting the integrated chinstrap would release the Shock Bonnet® and allow the head to fall into extension because the Shock Bonnet is not attached to the helmet shell. However, this fear seems unfounded as, there is no anecdotally observable movement about the head and neck complex when the chinstrap is cut.

High Quality CPR

Initial attempts to perform a modified jaw thrust maneuver (MJT) to open the airway and assess the athlete's breathing status are routinely complicated by the Aware-Flow® shock absorbers located on the mandible. Specifically, the snug fit of the Aware-Flow® shock absorbers make drawing the mandible forward during attempts to perform the MJT difficult.

To facilitate completion of a MJT in athletes wearing the Epic, sports medicine teams may consider the following observations:

1. Removing the Aware-Flow shock absorbers is not an option as they are integrated into the Shock Bonnet.
2. Cutting the chinstrap will loosen the Shock Bonnet and may allow for effective completion of the MJT.
3. Removing the face mask from the helmet results in the ability to better spread the helmet shell, making the MJT easier. However, facemask removal is time consuming and may not be practical in critical circumstances.
4. Removing the helmet from the athlete results in the ability to effectively complete a MJT.

None of the options presented above were found to be successful or most appropriate consistently enough to warrant them becoming a protocol suggestion for the emergency management of athlete's wearing the Epic. The prudent sports medicine team will be prepared to complete specific critical care management techniques when deemed most appropriate by a sports medicine team considering the primary objective of critical care at any given moment.

Facemask Removal

The Epic utilizes four traditional loop style facemask fasteners that are generally easy to remove using a power screwdriver. Occasional hardware failure was observed, but the loop strap fasteners are easily cut using any of the FMx3® techniques identified for use on traditional loop strap style fasteners.

There is risk of failure in all mechanical systems. Therefore, the prudent sports medicine team will not rely on any one approach to ensure the ability to complete critical care tasks during unpredictable on-field emergency management.

Helmet Removal

When properly fitted according to manufacturer guidelines and when using the helmet techniques outline above, the Xenith Epic is removed as easy as any other football helmet. Participants compared removing the Epic under various conditions, including removing the helmet with a normal fit, after having cut the integrated chinstrap, and following face mask removal. Helmet removal following face mask removal may be easier, but, in general, the helmet was removed under each condition without any anecdotally reported complications or with any observable difference in motion about the head and neck.

Conclusion

While conducting live simulation training there were a number of identified barriers to completion of critical care tasks in athlete's wearing the Riddell SpeedFlex, Schutt VTD II, and Xenith Epic. Generally, the barriers identified were consistent with each of these helmets, with only subtle variations in how a team may elect to address the barriers. When multi-disciplined sports medicine teams worked together to develop and practice strategies to overcome the observed barriers, none of these helmets ultimately represent any significant hindrance to a sports medicine team's critical care management goals. This observation ultimately reaffirms what the informed sports health care professional already knows. That annual review and practice of an appropriate emergency action plan is essential to effective completion of critical care tasks during an actual on-field sports emergency.