DE NOVO CLASSIFICATION REQUEST FOR Q-COLLAR

REGULATORY INFORMATION

FDA identifies this generic type of device as:

> **External compression device for internal jugular vein compression**. An external compression device for internal jugular vein compression is a non-invasive device that is intended to increase intracranial venous volume to reduce the occurrence of specific changes in the brain following head impacts.

NEW REGULATION NUMBER: 890.3050

CLASSIFICATION: Class II

PRODUCT CODE: QNX

BACKGROUND

DEVICE NAME: Q-Collar

SUBMISSION NUMBER: DEN200017

DATE DE NOVO RECEIVED: May 19, 2020

SPONSOR INFORMATION:

Q30 Sports Science, LLC
257 Riverside Avenue
Westport, CT 06880

INDICATIONS FOR USE

The Q-Collar is indicated as follows:

> The Q-Collar is a non-invasive device intended to be worn around the neck of athletes aged 13 years and older during sports activities to aid in the protection of the brain from effects associated with repetitive sub-concussive head impacts.

LIMITATIONS

- The Q-Collar has not been demonstrated to prevent long-term cognitive function deficits, and the ultimate impact on clinical outcomes has not been evaluated.
- The use of imaging studies as a future indicator of brain injury has not been validated.
- Data do not demonstrate that the device can prevent concussion or serious brain injury.

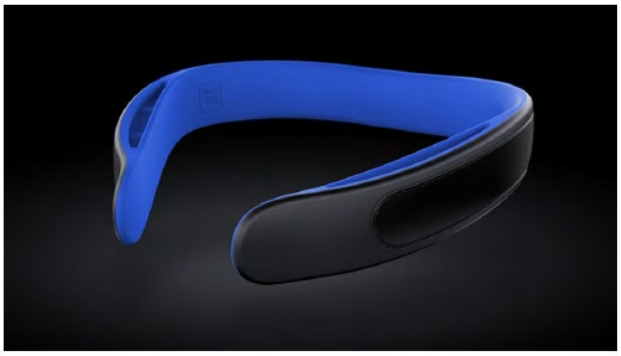
- The Q-Collar should not be worn if it interferes with other existing protective equipment.
- Wearers of the device should not depend on the device to protect them from all harmful effects of head impacts.

PLEASE REFER TO THE LABELING FOR A COMPLETE LIST OF WARNINGS, PRECAUTIONS AND CONTRAINDICATIONS.

DEVICE DESCRIPTION

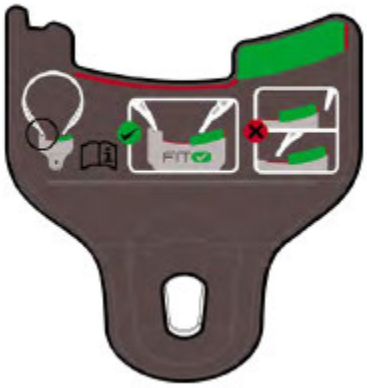
The Q-Collar (Figure 1) is a C-shaped collar intended to be worn around the neck during sports activities. The protuberances located at each end of the device are designed to ensure the correct location of pressure on the neck to provide compressive force to the internal jugular vein (IJV).

FIGURE 1: Q-COLLAR



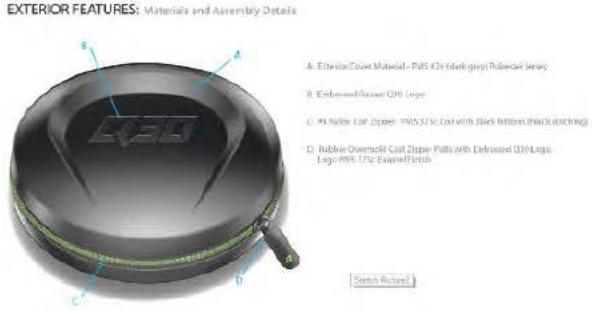
In order to confirm whether the Q-Collar is properly sized and fits the wearer correctly, an ancillary fitting tool, referred to as the Fit Check (Figure 2), is packaged with the Q-Collar.

FIGURE 2: FIT CHECK



The Q-Collar and Fit Check are packaged with a carry case (Figure 3) for transport and storage.

FIGURE 3: CARRY CASE EXTERIOR CONSTRUCTION



Principle of Operation:

The Q-Collar is designed to lightly compress (no more than (b) (4) pound-force and (b) (4) mmHg pressure) the sternocleidomastoid muscles in the neck, which provides compressive force to the internal jugular vein (IJV). The restriction in blood flow is designed to result in an increase in the volume of blood in the venous capacitance vessels within the skull. Whereas the brain generally has room to move slightly within the skull, the increased blood volume is intended to create a tighter fit and reduce intracranial movements within the skull. By reducing the movement of the brain within the cranial space, the Q-Collar may aid in the protection of the brain from the effects of head impacts.

SUMMARY OF NONCLINICAL/BENCH STUDIES

Bench force, biocompatibility and shelf life testing was required for the Q-Collar.

Test	Purpose	Method	Acceptance Criteria	Results
Bench Testing	Assess the minimum and maximum forces exerted by the Q-Collar.	Force Test	Q-Collars to provide a minimum of 0.75 pound-force when the tip gap (the distance between the two front tips of the device) is 1.5 inches, and a maximum of 3.5 pound-force when the tip gap is 2.5 inches.	Passed: Q-Collars exert a minimum of (b) (4) when the tip gap is (b) (4) and maximum of (b) (4) when the tip gap is (b) (4)
Cytotoxicity Testing	Determine the cytotoxicity of extractable substances from the Q-Collar.	The Minimal Essential Media (MEM) Elution Test	ANSI/AAMI/ISO 10993-5 standard states that the achievement of a numerical grade greater than 2 is considered a cytotoxic effect, or a failing score.	Passed: Each test article received a score ≤2).
Sensitization Testing	Determine the potential allergenic or sensitizing	Kligman Maximization Tests	ISO 10993-10 Tests for Irritation and Skin Sensitization guidelines.	Passed: No systemic signs of toxicity were observed in treated or control animals. (b) (4)

	capacity of the test articles.			(b) (4)
Irritation Testing	Determine the potential irritation effects of the test article extracts.	Intracutaneous Injection Tests (b) (4)	ISO 10993-10 Tests for Irritation and Skin Sensitization guidelines.	Passed: None of the animals exhibited overt signs of toxicity at any of the observation points. The (b) (4) of the test articles did not show a significantly greater biological reaction than the sites injected with the control articles.
Cycle and extreme temperature testing	Assess Q-Collar function and visual appearance before and after exposure to extreme temperature and cyclic loading.	1) (b) (4) cycles 2) Exposure to at least (b) hours of (b) (4) °F ((b) (4) °C) temperature and (b) (4) °F ((b) (4) °C) temperature.	Proper function of the Q-Collar is defined as exerting a minimum of 0.75 pound-force when the tip gap is 1.5 inches and a maximum of 3.5 pound-force when the tip gap is 2.5 inches.	Passed: function properly and pass visual inspection.
Ultraviolet resistance testing	Assess Q-Collar function and visual appearance following exposure to ultraviolet (UV) environmental cycling.	1) exposure to (b) (4) hours ((b) (4) days) of ASTM G154-12a, Cycle 2 (alternating (b) (4) hour periods of UV light and condensation). 2) exposure to (b) (4) hours ((b) (4) days) of ASTM G154-12a, Cycle 2 (alternating (b) (4) hour periods of UV light and condensation).	Proper function of the Q-Collar is defined as exerting a minimum of 0.75 pound-force when the tip gap is 1.5 inches and a maximum of 3.5 pound-force when the tip gap is 2.5 inches.	Passed: Q-Collars can be expected to generate a force no lower than (b) (4) at the minimum tip gap and no greater than (b) (4) at the maximum tip gap at least (b) (4) % of time.
Cleaning compatibility and chemical durability testing	Assess Q-Collar function and visual appearance (inspection for tears, deformities, and delamination) following exposure to cleaning agents and chemicals potentially present in the device's intended use environment.	1) cleaning with the following solutions at least (b) (4) times: (b) (4) . 2) exposure to saltwater or chlorinated water conditions for (b) (4) hours ((b) (4) days).	Proper function of the Q-Collar is defined as exerting a minimum of 0.75 pound-force when the tip gap is 1.5 inches and a maximum of 3.5 pound-force when the tip gap is 2.5 inches.	Passed: Q-Collars function properly and pass visual inspection following exposure to cleaning agents and chemicals potentially present in the Q-Collar's intended use environment.
Accelerated aging study	Assess Q-Collar function and visual appearance following simulated aging conditioning for the specified	(b) (4) years of simulated storage in the final packaging.	Proper function of the Q-Collar is defined as exerting a minimum of 0.75 pound-force when the tip gap is 1.5 inches and a maximum	In Process: Q-Collars function properly after simulated aging conditioning of 1 year and 2 years.

	storage life requirement.		of 3.5 pound-force when the tip gap is 2.5 inches.	
Transit testing	Assess Q-Collar function and visual appearance (inspection for tears, deformities, and delamination) following shipping conditioning (e.g., low temperature, high temperature, shock and vibration) and use conditioning (e.g., 520 falls from 1 m)	1) the Q-Collar functions after exposure in its shipping container to extreme cold, uncontrolled relative humidity per ISTA 2A (partial simulation test for individual packaged products); 2) the Q-Collar functions after exposure in its shipping container to hot, humid and extreme heat, moderate relative humidity per ISTA 2A; 3) the Q-Collar functions after shock and vibration testing in its shipping container per ISTA 2A; 4) the Q-Collar functions after (b) (4) falls from (b) meter and is classified as fit for use based on visual inspection for tears, deformities, delamination, and applying correct force.	Proper function of the Q-Collar is defined as exerting a minimum of 0.75 pound-force when the tip gap is 1.5 inches and a maximum of 3.5 pound-force when the tip gap is 2.5 inches.	Passed: Q-Collars can be expected to generate a force no lower than (b) (4) at the minimum tip gap and no greater than (b) (4) at the maximum tip gap at least 95% of time.

SUMMARY OF HUMAN FACTORS AND USABILITY TESTING

Human factors and usability testing were conducted which included a simulated use test and labeling comprehension test with (b) (4) participants from two different user groups:

- Adult users (18 years or older) involved in physical activities that may result in sports related impacts
- Parent/guardian-adolescent pairs, where the parents/guardians are 18 years or older and adolescents are 12 – 17 years old, involved in physical activities that may involve sports related impacts

Participants within these two user groups self-reported participating in sports that use protective equipment (e.g., football, hockey, lacrosse) and sports that do not use protective equipment (e.g., volleyball, soccer, cheerleading).

Users were provided with online instructional materials (informational content and videos) to determine the size of Q-Collar appropriate for themselves or an adolescent. Participants had access to the product website with instructional video and Fit Guide, a mirror, and measurement

equipment (e.g., measuring tape and other tools) but were not prompted to use any of the materials. Formal training was not provided. After selecting a size, the corresponding Q-Collar product was provided to the user in a sealed package. Both observational data and subjective evaluations were collected. Users also participated in a labeling comprehension study to demonstrate that users can identify and understand product warnings/cautions and how to correctly perform tasks.

(b) (4) out of (b) (4) participants were able to use the Fit Check Tool to confirm the proper fit of the Q-Collar or to determine the selected Q-Collar was not an appropriate fit. (b) (4) participants erroneously confirmed the fit of the Q-Collar by either misinterpreting results of the Fit Check tool or by incorrectly using the Fit Check tool.

(b) (4) out of (b) (4) participants successfully responded to questions related to actions taken after incurring a head injury while wearing the Q-Collar, indicating they understand the Q-Collar does not prevent head injury and medical treatment should be sought following head injury. (b) (4) participants overlooked "Seek medical care immediately if you experience symptoms of a concussion." in the device instructions and one participant demonstrated negative transfer by stating that they would not act differently than how they currently do in response to head impacts.

Overall, human factors and usability testing demonstrated that users understood how the device is intended to be used, including with other protective equipment..

SUMMARY OF CLINICAL INFORMATION

Five clinical trials, including three pilot studies and two pivotal studies, were conducted. Each trial is summarized below.

A. Pilot studies

1. **Pilot Hockey Study 2014-5009 (NCT02271451)**
   This clinical study was conducted in hockey athletes wearing the Q-Collar (n=7) and a control group of hockey athletes who did not wear the Q-Collar (n=8) during hockey competitions to test the Q-Collar's effect in reducing neuroanatomical and neurophysiological changes to the brain following head impacts. Participants were tested at pre-season, mid-season, and post-season using diffusive tensor imaging (DTI) and event related potentials (ERP) utilizing electroencephalography.

2. **Pilot Football Study 2015-2205 (NCT02696200)**
   This prospective, controlled clinical study was conducted in football athletes (males: (b) (4) years) who wore the Q-Collar during practices and games (n=31) and a control group of athletes who did not wear the Q-Collar (n=30) to test the Q-Collar's effect in reducing neuroanatomical changes to the brain following head impacts during a football season, measured using DTI.

3. **Pilot Soccer Study 2016-0988 (NCT03014492)**
This study utilized a prospective longitudinal controlled cohort study design to evaluate the effect of the Q-Collar (n=(b) (4) relative to control (no-Q-Collar: n=(b) (4) on long-term white matter changes in females ((b) (4) years) over three time-points spanning 9 months. Subjects underwent magnetic resonance imaging (MRI) scans pre-season, post-season, and 3 months post-season. The aims of the study were to: (1) quantify white matter alterations using DTI metrics during the soccer season and characterize the progression of white matter alteration 3 months post-season; (2) determine the association between white matter alterations and exposure to sub-concussive head impacts; and (3) evaluate the efficacy of mild jugular vein compression to ameliorate these white matter alterations over the three time points.

Results from all three pilot studies demonstrated that use of the Q-Collar resulted in no adverse events, indicating safety. Additionally, imaging suggested changes in cerebral white matter microstructure were in control groups but not those using the Q-Collar in each study. These studies informed the following pivotal trials.

B. Pivotal Study 1 – Football Study 2018-1123 (NCT04068883)

1. Study Design
This Pivotal Football Clinical Study was a prospective longitudinal study in which (b) (4) high school male football athletes were allocated to one of two investigational groups, 1) Athletes who wore the Q-Collar during the sports season (n=(b) (4) or 2) Athletes who did not wear the Q-Collar during the sports season (n=(b) (4) that were stratified by school (four teams primarily wore the Q-Collar and three teams primarily did not wear the Q-Collar).

An accelerometer device was affixed behind the ear of each athlete with an adhesive patch and measured the magnitude of every impact to the head sustained by the athlete by measuring linear accelerations and rotational velocities of the head. The data were filtered to remove spurious impact data and false-positive recordings. In addition, these head impact data were categorized into thresholds between 20 g (inclusive) and 150 g in 10 g intervals. This resulted in 13 additional head impact exposure levels (a total of 14 thresholds when including 20 g). Number of impacts and total g forces were calculated for each exposure threshold.

Each athlete underwent one pre-season magnetic resonance imaging (MRI) scan and one post-season MRI scan in order to determine differences in longitudinal brain imaging change between pre-season and post-season. Post-season scanning was completed at the end of the regular football season but before the start of any playoff games to account for the fact that teams could be eliminated at different times during the playoff period and may thus have different relative head impact exposures.

2. Enrollment

Inclusion Criteria

- Normal healthy volunteer
- Able to provide written consent
- Must be 13 years or older and a participant on a high school football team

Exclusion Criteria

- Unable to provide written consent
- History of neurological deficits, previous cerebral infarction, or severe head trauma as indicated through pre-season screening
- Medical contraindications to restriction of venous outflow via the internal jugular veins (known increased intracerebral pressure, metabolic acidosis, or alkalosis)
- Glaucoma (Narrow Angle or Normal Tension)
- Hydrocephalus
- Recent penetrating brain trauma (within 6 months)
- Known carotid hypersensitivity
- Known increased intracranial pressure
- Central vein thrombosis
- Any known airway obstruction
- Any known seizure disorder
- Prothrombotic or hyperthrombotic condition
- Cerebral cavernous malformation
- Athletes not medically cleared to play sports

3. Clinical Endpoints

Primary Effectiveness Endpoint

Change in pre-defined DTI metrics [Mean Diffusivity (MD), Axial Diffusivity (AD) and Radial Diffusivity (RD)] in whole brain from pre-season to post-season in athletes who wore the Q-Collar and athletes who did not wear the Q-Collar.

Primary Safety Endpoint

Incidence of serious adverse events, e.g., syncope, loss of consciousness, associated with the Q-Collar during the sports season.

4. Results

Significant pre-season to post-season reductions in MD, AD, and RD were found in extensive white matter regions [left and right anterior thalamic radiation (ATR), left and right cingulum (cingulate gyrus part), forceps minor, left and right inferior fronto-occipital fasciculus (IFOF), left and right superior longitudinal fasciculus (SLF), left and right uncinate fasciculus (UF), and the right temporal SLF] in the no-Collar group (n = (b) (4) p < (b) (4) but not in the Collar group (n = (b) (4) p > (b) (4) Significant greater RD reductions are shown in the no-Collar group compared to the Collar group (p<(b) (4) in right IFOF and right ATR. Both Collar and no-Collar groups show significant pre-season to post-season increases in FA and/or AD in some white matter region [left and right ATR, left cingulum (cingulate gyrus part), left cingulum (hippocampus part), forceps

major, left IFOF, left inferior longitudinal fasciculus (ILF), left SLF, left corticospinal tract (CST)]. Increases of FA and AD were not significantly different between Q-Collar and no-Collar group.

(b) (4)

Column A: White matter regions with significant pre-season to post-season reductions in MD, AD, and RD in the no-Q-Collar group (all p < (b) (4) Column B: No significant pre-season to post-season reductions were observed for the Q-Collar group (all p > (b) (4) Column C: Between-group differences demonstrating a significantly greater pre-season to post-season RD reduction for the no-Q-Collar group compared to the Q-Collar group (p < (b) (4) Column D: No significant between-group white matter reductions were observed for the Q-Collar group compared to the no-Q-Collar group.
Numbers in lower right of each individual image represent the number of significant voxels.
*Covariates included baseline DTI metrics, scanner, number of head impacts > (b)(4) g, and time interval between last head impact to post-season scanning.

Post-hoc analysis revealed that 1) delta FA was positively correlated with head impact exposure in the no-Collar group (p<(b) (4) but negatively correlated with head impact exposure in the Collar group (p<(b) (4) at threshold of (b) (4)) delta MD was significantly negatively correlated with head impact exposure in the Q-Collar group, but significantly positive correlated with head impact exposure in the no-Collar group (p<(b) (4) at threshold of (b) (4) and (b) (4) (b)(4) delta MD was significantly negatively correlated with head impact exposure in the Q-Collar group (p<(b) (4) but

significantly positively correlated with head impact exposure in the Q-Collar group (p<(b) (4) at threshold of (b) (4) (b) (4) and (b) (4)

Column A and B: White matter regions with significant pre-season to post-season increases in FA in the no-Q-Collar group (Column A; all p < (b) (4) and Q-Collar group (Column B; all p < (b) (4)
Column C and D: No significant between-group white matter increases were observed for the no-Q-Collar group compared to the Q-Collar group (Column C) or between the Q-Collar group compared to the no-Q-Collar group (Column D).
Numbers in lower right of each individual image represent the number of significant voxels.
*Covariates included baseline DTI metrics, scanner, number of head impacts > (b)(4) g, and time interval between last head impact to post-season scanning.

These results indicate that the relationships between cumulative head impact exposure and pre-season to post-season changes in DTI metrics were modulated by the Q-Collar at the higher exposure thresholds but not at lower threshold (from > (b)(4) g to > (b) (4) g). Results from this study demonstrated that that the Q-Collar reduces changes in DTI metrics when controlling for total head impact exposure and that the Q-Collar modulates the relationship between head impact exposure and changes in pre-season to post-season DTI metrics at higher magnitude exposure levels ((b) (4) g to (b) (4) g).

No adverse events or serious adverse events (e.g., syncope, loss of consciousness, etc.) due to device use were reported during the study.

C. Pivotal Study 2 – Soccer Study 2018-1123 (NCT04068883)

1. Study Design

This Pivotal Soccer Clinical Study was a prospective longitudinal study in which (b) (4) high school female soccer athletes were allocated to one of two investigational groups, 1) Athletes who wore the Q-Collar during the sports season (n=(b) (4) or 2) Athletes who did not wear the Q-Collar during the sports season (n=(b) (4) that were stratified by school (4 teams primarily wore the Q-Collar and 4 teams primarily did not wear the Q-Collar).

An accelerometer device was affixed behind the ear of each athlete with an adhesive patch and measured the magnitude of every impact to the head sustained by the athlete by measuring linear accelerations and rotational velocities of the head. The data were filtered to remove spurious impact data and false-positive recordings.

Each athlete underwent one pre-season MRI scan and one post-season MRI scan in order to determine differences in longitudinal brain imaging change between pre-season and post-season. Post-season scanning was completed at the end of the regular soccer season but before the start of any playoff games to account for the fact that teams could be eliminated at different times during the playoff period and may thus have different relative head impact exposures.

2. Enrollment

Inclusion Criteria

- Normal healthy volunteer
- Able to provide written consent
- Must be 13 years or older and a participant on a high school soccer team

Exclusion Criteria

- Unable to provide written consent
- History of neurological deficits, previous cerebral infarction, or severe head trauma as indicated through pre-season screening
- Medical contraindications to restriction of venous outflow via the internal jugular veins (known increased intracerebral pressure, metabolic acidosis or alkalosis)
- Glaucoma (Narrow Angle or Normal Tension)
- Hydrocephalus
- Recent penetrating brain trauma (within 6 months)
- Known carotid hypersensitivity
- Known increased intracranial pressure
- Central vein thrombosis
- Any known airway obstruction
- Any known seizure disorder
- Prothrombotic or hyperthrombotic condition
- Cerebral cavernous malformation
- Athletes not medically cleared to play sports

3. Clinical Endpoints

Primary Effectiveness Endpoint

Change in DTI derived brain networks and functional MRI (fMRI)-derived brain network measures (global clustering coefficient (C_g), characteristic path length (L), modularity (Q), normalized clustering coefficient (γ), normalized path length (λ), small world-ness (σ), and clustering coefficient at the nodal level (Cn)) in whole brain from pre-season to

post-season in athletes who wore the Q-Collar and athletes who did not wear the Q-Collar.

Primary Safety Endpoint
Incidence of serious adverse events, e.g., syncope, loss of consciousness, associated with the Q-Collar during the sports season.

4. Results

fMRI-derived graph measures show significant increase in C_g and change in path length (L) for the no-Collar group. Additionally, the change in C_g was significantly different between groups. Cn in general were increased in the no-Collar group, but no significant difference was found at any node after controlling for multiple comparisons. No significant changes were observed for the Collar group for any graph measure in any of the 3 models. DTI derived graph measures show significant increase in Q for the no-Collar group. No significant changes were observed for the Collar group for any graph measure. Change in Q was significantly greater in the no-Collar group vs. Collar group when controlling for scanner only, but not when additional controlling for filtered accelerometer data.

Graph theory is used to translate functional and structural connectivity data into a simplified model of the brain as a network at a macroscopic level. The fMRI-derived brain networks of no-Collar group exhibited an increased C_g (meaning functional similar nodes become increasingly connected) and L (meaning an erosion of connectivity between functionally distinct nodes). The DTI-derived brain networks did not exhibit increase L in the no-Collar group but showed increase Q (increase in Q may be driven by decreases in connectivity between nodes in different modules and/or increases in connectivity between nodes in the same module). Both DTI and fMRI-derived networks from Collar group displayed no significant changes.

FIGURE 13: LONGITUDINAL CHANGES IN AUC OF CLUSTERING COEFFICIENT AT THE NODAL LEVEL (C_N) FOR NO-Q-COLLAR (A, B) AND Q-COLLAR (C, D) GROUPS

(b) (4)

Spheres represent nodes and are positioned at the center of mass of their respective Automated Anatomical Labeling (AAL) defined region of interest. Lines are representative of the average subject's network edges at a density level of 0.2; cross-hemispheric connections are hidden to improve readability.

The results indicate that there may be alterations in brain structure and function after a soccer season with sub-concussive head impacts and that the Q-Collar may mitigate such alterations in brain network properties.

No adverse events or serious adverse events (e.g., syncope, loss of consciousness, etc.) associated with the Q-Collar occurred during the study.

LABELING

The Q-Collar instructions for use are consistent with the clinical data and cover all the hazards and other clinically relevant information that may impact use of the device. The labeling is sufficient and satisfies the requirements of 21 CFR § 801 Subpart C – Labeling Requirements for Over-the-Counter Devices.

The following warnings and precautions are included within device labeling:

- The Q-Collar does not replace, and should be worn with, other protective sports equipment associated with specific sports activities, such as helmets and shoulder pads.
- The Q-Collar should not be worn if it interferes with other existing protective equipment.
- Users should avoid head and neck impacts to the extent possible.
- Serious harm can result from persistent, excessive pressure on the neck due to incorrect Q-Collar size and fit.
- Data do not demonstrate that the device can prevent concussion or serious brain injury.

- Wearers of the device should not depend on the device to protect them from all harmful effects of head impacts.
- The use of imaging studies as a future indicator of brain injury has not been validated.
- The Q-Collar has not been tested and should not be used on athletes with the following conditions:
  - Increased pressure in the skull (including uncontrolled ocular-glaucoma)
  - Increased presence of acid in the body or excessive blood alkalinity
  - Open head injury (including in or around the eye) within the past six months
  - Pseudotumor cerebri (false brain tumor)
  - Presence of brain or spinal shunt
  - Accumulation of cerebrospinal fluid within the brain
  - Known seizure disorder
  - Known trachea abnormality
  - Known airway obstruction
  - Known carotid hypersensitivity
  - Blood clot in the brain
  - Increased likelihood of blood clotting (coagulation)
  - Collections of small blood vessels in the brain that are enlarged and irregular in structure
  - Skin injury, rash, or other abnormality on or around the neck

The labeling also includes:

- Information on how the device operates and the typical sensations experienced during use
- Information in the Instructions for Use regarding how to place the device on the user
- Storage and cleaning instructions for the device
- Physical limitations of the device including suitable temperature range, duration of use, and expected product life.

RISKS TO HEALTH

The table below identifies the risks to health that may be associated with use of an external compression device for internal jugular vein compression and the measures necessary to mitigate these risks.

Identified Risks to Health	**Mitigation Measures**
Syncope due to excessive compression	Human factors testing Non-clinical performance testing Labeling
Use error, interference with other equipment, or ineffective treatment leading to impact-related trauma or injury	Human factors testing Labeling
Adverse tissue reaction	Biocompatibility evaluation

SPECIAL CONTROLS

In combination with the general controls of the FD&C Act, the external compression device for internal jugular vein compression is subject to the following special controls:

1. The patient-contacting components of the device must be demonstrated to be biocompatible.

2. Non-clinical performance testing must demonstrate that the device performs as intended under anticipated conditions of use, including the following:

    a. compression testing; and
    b. durability testing over the labeled use life.

3. Human factors and usability testing must demonstrate that users can correctly use the device, including:

    a. confirming the proper size and fit of the device; and
    b. Understanding the device labeling, including the warning that the device does not prevent head injury and medical treatment should be sought following head injury.

4. Labeling must include the following:
    a. A warning that the device does not replace, and should be worn with, other protective sports equipment associated with specific sports activities, such as helmets and shoulder pads.
    b. A warning that the device should not be worn if it interferes with other existing protective equipment.
    c. A warning that users should avoid head and neck impacts to the extent possible.
    d. A warning that serious harm can result from persistent, excessive pressure on the neck due to incorrect device size and fit.

BENEFIT-RISK DETERMINATION

The risks of the external compression device for internal jugular vein compression are based on data collected in the clinical studies described above. Although no adverse events or serious adverse events (e.g., syncope, loss of consciousness, etc.) were reported during the studies, based on products with a similar mechanism of action and other clinical knowledge, there are probable risks to patient health without adequate mitigations in place:

- Small amounts of excessive pressure to the muscles surrounding the IJV could disrupt the flow of oxygenated blood through the arteries to the brain leading to syncope.
- Use error could cause injury to the user including excessive head impacts caused by a false sense of protection, use of the device by athletes who should not wear the device, or interference with existing protective equipment (e.g., helmet).

- Incompatible materials could lead to adverse tissue reaction, such as skin irritation.

The probable benefits of the device are also based on data collected in clinical studies as described above. Benefit was demonstrated as reductions in changes in brain structure/function, as evidenced with DTI and fMRI, that are thought to be related to protection of the brain following repetitive sub-concussive head impacts. These benefits were demonstrated in athletes who used the device through a sports season. These changes in DTI have not been validated as a measure of brain injury or linked to clinical outcomes. Similarly, there is uncertainty surrounding the relationship of fMRI-derived brain network measures with brain structure/function. The metrics used in the study were not those that were pre-specified, lending to uncertainty in the results. However, given the urgent need for protection of the brain following mild head impacts as a result of sports and the low risk of this device, the probable benefits outweigh the probable risks.

Patient Perspectives

This submission did not include specific information on patient perspectives for this device.

Benefit/Risk Conclusion

In conclusion, given the available information above, for the following indication statement:

> The Q-Collar is a non-invasive device intended to be worn around the neck of athletes aged 13 years and older during sports activities to aid in the protection of the brain from effects associated with repetitive sub-concussive head impacts.

the probable benefits outweigh the probable risks for the Q-Collar. The device provides benefits and the risks can be mitigated by using general controls and the identified special controls.

CONCLUSION

The De Novo request for the Q-Collar is granted and the device is classified as follows:

> Product Code: QNX
> Device Type: External compression device for internal jugular vein compression
> Regulation Number: 21 CFR 890.3050
> Class: II