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Axial Organ (AxO):

A Position Paper on Definition,

Boundaries, and Functional Organization

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Abstract

Interpreting local axial findings in relation to posture, movement, or regulation requires a defined system of reference. This paper develops the Axial Organ (AxO), introduced in Position Paper No. 1, as an anatomical–physiological domain of normal axial activity, adaptation, and disruption. It distinguishes structural inclusion, shared function, and influence across system boundaries.

The AxO includes the pelvic ring, vertebral column, rib cage, cervico-cranial junction, and entire skull, including the mandible. Its classification covers temporomandibular units, sphenoid relationships, the hyoid complex, shared respiratory–postural and proximal airway components, peripheral neural supply, and meningeal interfaces. Muscle force, pressure, connective-tissue mechanics, and afferent return interact with central control in a recursively updated sensorimotor system. The central nervous system regulates the AxO but is not a component.

The Somato-Psychic Pathway (SPP) is interpreted as the broader regulatory–developmental domain of autoregulation and neurodevelopment. Local Axial Block (AxB), regional interaction, and AxO state remain distinct from Persistent Afferent Bias (PAB), which concerns persistent altered afferent conditions and their regulatory weighting. SPP's proposed developmental ordering is retained alongside reciprocal ongoing regulation.

Examination combines static and dynamic observation in developmentally appropriate conditions, including cranial and orofacial assessment and neonatal and infant postural reactions. Direct observation of the entire unclothed body requires consent, privacy, thermal comfort, and safety safeguards. Asymmetry and axial eccentricity are assessed separately. Intended uses include clinical description, teaching, and research design; whole-system validity, reliability, and added value require testing.

Keywords: Axial Organ; Axial Corresponding Functional Unit; axial biomechanics; sensorimotor integration; afferent signaling; autonomic innervation; superior thoracic aperture; temporomandibular joint; hyoid complex; respiratory–postural coupling; developmental examination; axial eccentricity

Purpose of this Position Paper

A local axial finding can be interpreted at regional or system level only if the system is defined. SPP Institute Position Paper No. 1 (PP1) defined Axial Block (AxB), multiple Axial Blocks

(AxBb), the articulation-centered Axial Corresponding Functional Unit (AxCFU), and the Axial Organ (AxO). This position paper (PP2) specifies the AxO's component classes, shared structures, and regional relationships so that examination methods and mechanistic claims refer to the same system (Živný & Živná, 2026).

The AxO is conceptualized as an actively controlled, recursively updated sensorimotor system: the anatomical–physiological domain of normal axial activity, adaptation, and disruption. Neurally controlled skeletal muscle generates force; articular and connective tissues transmit and constrain it; and afferent signaling returns information to central regulation. Respiratory and pressure-regulating structures share these functions.

Building on functional anatomy, kinesiology, and spinal-stabilization models, PP2 defines a pelvic-to-cranial framework that distinguishes structural inclusion, shared function, and influence across boundaries. It relates local AxCFUs and AxB to regional interactions and the state of the entire AxO.

This somatic system connects PP1's local terminology with the broader regulation addressed by the Somato-Psychic Pathway (SPP) and Persistent Afferent Bias (PAB). Its intended uses are clinical description, interdisciplinary communication, teaching, and research design (Živný, 2026a, 2026b; Živný & Živná, 2026).

Statements 1–6 define boundaries; Statements 7–10 develop the mechanics and neural relationships; Statements 11–13 address system state and examination. Figure 1 locates components; Figure 2 shows the regulatory loop. Abbreviations are listed in Table 8.

Separate position papers will develop examination and intervention methods.

Conceptual Orientation: AxO and SPP as Complementary Domains

An anatomical–physiological domain comprises tissues, states, and interactions within a defined bodily extent. AxB is one local disturbance within the AxO. Domain describes the scope of the published definition rather than a new anatomical compartment.

SPP links somatic, autonomic, emotional, and cognitive processes in a developmentally ordered regulatory continuum, with reciprocal influences during ongoing regulation (Živný, 2026b). Here, it is interpreted as the regulatory–developmental domain of autoregulation—physiological self-regulation—and neurodevelopment. Domain denotes the regulatory context; trajectory denotes the proposed developmental ordering.

AxO and SPP describe related levels, not separate physical spaces. Afferent signaling and returning motor and autonomic influences connect axial tissues with broader regulation. PAB is a proposed persistent bias within this relationship (Živný, 2026a). The AxO is one relevant somatic domain, not the body's only source of regulatory influence.

Scope and Evidence Status

The definitions are stipulative. Regional studies support specific anatomical relationships, tissue properties, and physiological interactions; their integration into the complete AxO remains a proposal. The commentary and tables distinguish observations, interpretations, classification choices, and hypotheses. Historical usage establishes precedent, not validity.

Anatomical continuity identifies a connection; its functional magnitude and direction require region- and condition-specific evidence. Neural markers require functional characterization before a sensory modality can be assigned. Clinical observations may motivate a construct but do not establish diagnostic validity or treatment effects. For example, adult airway findings support consideration of a shared cervical–cervicothoracic component, while developmental generalization and axial function require further study (Kohno et al., 2019; Safshekan et al., 2016; Wong et al., 2008).

Statement 13 sets examination principles, not a validated protocol, normative scale, or intervention prescription. Whole-body observation requires consent, assent where applicable, privacy, chaperoning, thermal comfort, dignity, and clinical safety. Vojta-derived concepts inform position and test selection; they do not validate AxO-specific constructs.

Terminology for regional transitions. Cervico-cranial junction (CCJ) denotes the occiput–C1–C2 complex termed craniocervical or craniovertebral junction in the cited literature. The PP1 definition and reference titles retain their published wording. Upper thoracic aperture (UTA) means the superior thoracic aperture; cervicothoracic junction (CTJ) denotes the C7–T1 vertebral transition. The oblique aperture and vertebral transition overlap regionally but differ geometrically.

Cranial terminology. Skull denotes the neurocranium and facial skeleton, including the mandible; cranial region includes their directly participating tissues. The cranial base is a subregion, not the rostral limit of AxO. Temporomandibular joint (TMJ; plural TMJs) denotes either articulation; the craniomandibular subsystem comprises both joints, the mandible, and associated tissues. Spheno-occipital junction is stage-neutral: synchondrosis specifies retained cartilage, and synostosis specifies bony fusion.

Historical and Terminological Context

Human use of axial organ and Achsenorgan

D. Müller's 1964 chapter, Das Problem der Funktion und der Form des Achsenorgans, is documented in his later self-citation (D. Müller, 1968, reference 67). The original was not consulted. Later German titles address functional disorders and insufficiency (Müller-Stephann, 1965; Peter, 1970). These records document earlier human usage, not first use or equivalent AxO boundaries.

Central European rehabilitation and kinesiology used *axial organ* (Czech: *osový orgán* or *axiální orgán*) and *axial system* with varying scope. Roth addressed developmental and biomechanical relationships between the vertebral column and spinal cord–nerve-root complex; Diaconescu described osteo-fibro-musculo-articular relationships (Diaconescu, 1987; Roth, 1989). Both extend beyond an osseous grouping.

Kubíková (2012, p. 63), citing Dylevský's 2009 account, includes spinal and thoracic structures, respiratory and pelvic-floor muscles, and a control component. This attribution was not verified against Dylevský's books. Vyskotová (2013, sections 1.2–1.4) includes temporomandibular and masticatory functions in the upper cervical sector and respiratory–postural coordination. These teaching accounts document a multicomponent, neurally regulated tradition rather than independently validating its physiological claims.

Vostal (2019, p. 17) delimited a working space between the cranial base and pelvic floor. This was his own choice, not a verified Dylevský quotation. PP2 instead includes the entire skull and pelvic ring and assigns other components by structural or functional role.

Panjabi's (1992) spinal stabilizing system comprises passive, active, and neural subsystems with sensory monitoring, muscle recruitment, and adaptation. Figure 2 builds on this control logic; PP2 differs by placing central regulators outside its included peripheral system.

Slovak-language literature also uses axial system for spinal posture and loading (Čuj et al., 2019). This usage does not establish direct transmission between the national traditions.

Czech rehabilitation uses deep stabilization system and deep spinal stabilization system. Kolář and Lewit (2005) describe coordinated muscular stabilization during static loading and movement. English-language Dynamic Neuromuscular Stabilization (DNS) literature uses integrated spinal stabilizing system (ISSS) and applies developmental kinesiology to assessment and rehabilitation (Frank et al., 2013; Kobesova et al., 2020). These constructs

overlap with AxO in muscular coordination and pressure regulation. Their distinction lies in inclusion criteria and system boundaries, not an absence of neural control or connective-tissue relationships.

Manual-medicine and osteopathic antecedents

Manual medicine and osteopathy offer models of spinal functional units, somatic dysfunction, regional interdependence, fascial and cranial–spinal continuity, and whole-soma compensation. Zink and Lawson's common compensatory pattern is considered through Danto's (2003) integrated neuromusculoskeletal account; their original was not consulted. Tozzi (2015) proposes a neuro-fasciagenic model, while Potekhina et al. (2020) review articular, myofascial, vascular, lymphatic, muscular, and neural mechanisms. These clinical and conceptual accounts require separate evaluation of their anatomical claims, compensatory patterns, and treatment effects.

Willard et al. (2012) integrate passive thoracolumbar-fascial mechanics, active muscle forces, and sensory feedback. Their regional account is an antecedent of the force-generation, transmission, and afferent-return model developed in Statements 7–8.

Cranial osteopathy emphasizes skull, mandibular, and meningeal relationships. PP2 evaluates this anatomy separately from the primary respiratory mechanism (PRM), a diagnostically palpable cranial rhythmic impulse, and prescribed cranial-bone motion patterns, none of which it adopts. Demonstrated dural connections also do not establish unrestricted craniosacral transmission (Feipel et al., 2003; Geers et al., 2003; G. D. Hack et al., 1995; Humphreys et al., 2003; Zhuang et al., 2022).

Sommerfeld et al. (2004) found no reliable inter- or intraexaminer agreement for the tested PRM palpation measures in 49 healthy participants. Nelson et al. (2001) reported correspondence between palpated rhythms and low-frequency blood-flow oscillations. Vascular oscillation and palpation do not by themselves demonstrate sutural or spheno-occipital movement or a sphenoid-driven craniosacral mechanism.

Evidence-supported occipital–vertebral continuity

The basal and condylar occipital regions form part of the occipitocervical developmental field and the occiput–C1–C2 complex. This supports their axial continuity independently of cranial osteopathic mechanisms (David et al., 1998; F. Müller & O'Rahilly, 1994, 2003; Pang & Thompson, 2011; Shapiro & Robinson, 1976). Statement 3 addresses the developmental boundaries.

Unrelated zoological homonym

The echinoderm axial organ is an unrelated zoological structure and should be excluded from human AxO searches (Golconda et al., 2019).

Table 1. Historical and contemporary concepts related to the Axial Organ

Tradition or construct	Typical emphasis	Relationship to proposed AxO	Principal limitation or distinction
Achsenorgan (early German literature)	Axial-organ function, form, and dysfunction	D. Müller's 1968 self-citation documents the 1964 chapter title (reference 67).	Earlier usage, not established first use or equivalent boundaries.
Czech axial-system and regional kinesiology accounts	Multicomponent axial organization, central control, respiratory–postural and craniomandibular relationships (Kubíková, 2012; Vostal, 2019; Vyskotová, 2013).	Functional and spatial antecedents; Dylevský is cited indirectly.	Teaching and thesis accounts differ in scope; some include central regulators or exclude girdles. They do not validate AxO.
Deep stabilization concepts; ISSS; DNS	Developmentally informed coordination of axial and abdominal muscles, diaphragm, pelvic floor, and intra-abdominal-pressure regulation	Overlap with active muscular and pressure regulation	Stabilization constructs, not AxCFUs or the entire AxO.
Spinal functional unit / motion segment	Local intervertebral biomechanics	Precedent for local functional organization	Restricted to vertebral segments and narrower than AxCFU.
Panjabi's spinal stabilizing system (1992)	Passive, active, and neural subsystems; sensory monitoring, adaptation, and muscle control.	Antecedent of closed-loop control.	Includes central regulators, which PP2 places outside the AxO component boundary.

Tradition or construct	Typical emphasis	Relationship to proposed AxO	Principal limitation or distinction
Osteopathic soma and compensatory patterns	Whole-body structural, fascial, respiratory, adaptive, and sometimes neural relationships	Systems thinking and transitional-region relationships	Broader, discipline-specific models; AxO specifies neuromuscular control and evidence requirements.
Cranial osteopathy	Whole-skull, mandibular, cranio-cervical, and meningeal relationships, with additional proposed cranial rhythms.	Cranial anatomy and motor relationships evaluated independently of disputed mechanisms.	PP2 does not adopt PRM, prescribed cranial-bone motion patterns, or mobility of a fused spheno-occipital junction.
Contemporary fascia research	Regional force transmission, sensory innervation, and nociception	Regional connective-tissue transmission and sensory participation	Regional evidence; slow myofibroblast tension is not phasic motor activity.
Craniospinal meningeal anatomy	Dural continuity, myodural bridges, meningovertebral anchoring, and dural innervation	Supports a meningeal subsystem with focal axial attachments.	Local attachments do not establish unrestricted long-range transmission.
Somatic dysfunction	Multicomponent skeletal, articular, myofascial, vascular, lymphatic, and neural disturbance	Overlaps with multicomponent functional reasoning	A dysfunction construct; broader than AxO and not synonymous with AxB.
Axial skeleton	Bones forming the body axis	Provides much of the osseous substrate	An anatomical classification, not the complete functional system.

Tradition or construct	Typical emphasis	Relationship to proposed AxO	Principal limitation or distinction
Echinoderm axial organ	Discrete zoological structure of the axial complex	No conceptual relationship	Unrelated homonym; must be excluded from human AxO searches.

Abbreviations: DNS, Dynamic Neuromuscular Stabilization; ISSS, integrated spinal stabilizing system; PRM, primary respiratory mechanism.

Statement 1. Axial Organ (AxO)

Primary Definition

*For the purposes of this position paper, the **Axial Organ (AxO)** is defined as the continuous biomechanical and neurophysiological system extending from the pelvic ring through the vertebral column, the rib cage, including its articulations, and the craniovertebral junction to the skull. The cranial region includes the entire skull—the neurocranium and facial skeleton, including the mandible—together with its articulations and directly participating tissues. The occipital bone—particularly its basioccipital and condylar components—forms the rostral osseous continuation of the vertebral axis within this larger cranial region. The hyoid complex is a suspended, non-articulating functional component. The laryngeal and cervical–cervicothoracic tracheal framework is a shared airway-related component in its directly contributing axial roles, not an extension of the osseous-articular core.*

Commentary

The first sentence retains the PP1 definition verbatim (Živný & Živná, 2026). The remaining sentences specify its cranial extent, the suspended hyoid, and the shared proximal-airway components.

The vertebral column’s pelvic, thoracic, cranial, craniomandibular, and hyoid relationships support load transfer, posture, movement, respiration, and orofacial motor function. These relationships determine which soft-tissue, vascular, and peripheral neural roles the classification must address.

Organ denotes a functional system broader than the axial skeleton but more bounded than the musculoskeletal system, not a discrete organ in conventional gross anatomy.

Defining Characteristics

- continuous organization from the pelvic ring to the skull;

- vertebral column, rib cage and articulations, superior thoracic aperture, CCJ, and entire skull, including the mandible and TMJs;
- occipital bone, especially its basioccipital and condylar regions, as the rostral osseous continuation of the vertebral axis;
- hyoid complex as a suspended component rather than an articulation-centered AxCFU;
- role-specific inclusion of the laryngeal and cervical–cervicothoracic tracheal framework without incorporating the complete respiratory system;
- integration of osseous, articular, ligamentous, muscular, fascial, vascular, peripheral somatic and autonomic neural, and sensorimotor components; and
- graded, regionally heterogeneous biomechanical and neurophysiological interdependence.

Statement 2. Functional-Systems Status of the AxO

Primary Definition

*The **AxO** is a functional-systems construct comprising the structural, mechanical, sensorimotor, vascular, and directly participating peripheral somatic and autonomic neural components whose coordinated activity maintains and regulates the body axis; the term does not imply a discrete organ in conventional gross-anatomical nomenclature. The brain, spinal cord, and central autonomic network regulate the AxO but are not themselves components of it.*

Commentary

Domain denotes the organized tissues and interactions; state denotes their current configuration; process denotes change. These distinctions apply to normal activity, adaptation to load, and disruption.

Joints, muscles, connective tissues, and pressure-dependent mechanisms provide mechanical coupling. Peripheral somatic and autonomic pathways connect them with central regulation. The distributed system has no unique capsule, vascular pedicle, or nerve.

Shared nerves, trunks, ganglia, and plexuses are included only through their direct AxO supply and functions. Enclosure within the vertebral canal does not make the spinal cord an AxO component.

Each included structure must have a defined axial role and component class.

Defining Characteristics

- a defined axial domain rather than the whole musculoskeletal system;
- coordination of multiple tissue types and regulatory levels;
- distributed peripheral somatic and autonomic participation with central regulation;
- exclusion of the brain, spinal cord, and central autonomic network despite their regulatory role;
- functional identity beyond the osseous substrate; and
- defined boundaries and component classes for empirical testing.

Statement 3. Structural Core and Regional Extent

Primary Definition

*The **structural core of the AxO** comprises the pelvic ring; the vertebral column, including the sacrum and coccyx; the rib cage, including the ribs, costal cartilages, sternum, and their articulations; the cervico-cranial junction; and the entire skull—the neurocranium and facial skeleton, including the mandible—with its articulations. The occiput–C1–C2 complex connects the skull to the vertebral column. The sphenoid is included as a cranial-base and craniofacial component with masticatory and meningeal relationships.*

Commentary

The sacrum links the vertebral column and pelvic ring; the occiput links the vertebral axis and cranial base. These overlapping regions connect adjacent structural domains.

The pelvic ring comprises the paired hip bones, sacrum, sacroiliac joints, pubic symphysis, and stabilizing tissues. Sacroiliac and thoracolumbar-fascial anatomy support spinal–pelvic load transfer and lumbopelvic stabilization (Vleeming et al., 1995, 2012; Willard et al., 2012). Hip joints and femora influence pelvic mechanics but remain appendicular boundary interfaces.

Human specimen experiments show that rib and sternal integrity affect thoracic spinal range of motion, neutral zone, stiffness, and segmental stability. Costosternal connections contribute to global thoracic stability; costovertebral and costotransverse articulations contribute to segmental stability (Liebsch et al., 2017; Liebsch & Wilke, 2022). These in-vitro findings support rib-cage–spine coupling, not living or pediatric AxO reference values.

CCJ bone geometry, ligamentous constraints, and motion distribution differ from those of the subaxial spine (Lopez et al., 2015; Steinmetz et al., 2010). The occiput–C1–C2 connection is

part of the larger cranial region. Including the skull does not include the brain or other enclosed organs.

In 145 serially sectioned human embryos, F. Müller and O'Rahilly (2003) traced medial perinotochordal and sclerotomic contributions to the basioccipital and vertebral centra. Laterally, sclerotome 4 contributes to the exoccipital and condyle, 5 to the posterior atlas arch, and 6 to the axis arch. Their account qualifies simple proatlas/resegmentation narratives and distinguishes human from avian development (David et al., 1998; F. Müller & O'Rahilly, 1994, 2003).

Occipital–vertebral developmental continuity is strongest in the basioccipital and exoccipital/condylar regions. The supraoccipital and interparietal regions are not assigned identical vertebral homology; the interparietal component ossifies in membrane (Shapiro & Robinson, 1976). Inclusion of the entire occiput is a functional classification, not a claim that every part is developmentally vertebral.

Craniomandibular organization

Applying the PP1 definition, each TMJ centers an AxCFU completed by its muscles, ligaments, disc, capsule, vessels, and peripheral neural supply (Živný & Živná, 2026). The shared mandible couples the two units within a craniomandibular regional subsystem.

Adult recordings show coordinated mandibular and head–neck movement during opening, closing, and rhythmic jaw tasks (Eriksson et al., 1998, 2000). Surface and intramuscular electromyography (EMG) during biting also show task-dependent neck-muscle co-activation, including low-level sustained activity (Hellmann et al., 2012). This supports regional motor coupling, not a fixed occlusion-to-posture causal sequence, pediatric norms, or treatment efficacy.

The craniomandibular subsystem acts with hyoid, lingual, perioral, pharyngeal, and cervical structures in orofacial motor function (Vyskotová, 2013, section 8). Orofacial findings during the authors' axial examinations motivated explicit TMJ inclusion. This clinical rationale supplies no new dataset and does not attribute all orofacial dysfunction to the TMJs.

Sphenoid: structural, muscular, and meningeal roles

The sphenoid (os sphenoidale) links the cranial base with the facial and masticatory apparatus through its greater wing and pterygoid attachments. In human cadavers, Sritara et al. (2021) mapped lateral-pterygoid bundles from the greater wing and lateral pterygoid plate to the

condylar region, with differentiated disc and bony attachments. These provide an anatomical route linking sphenoid and mandibular mechanics.

Kimball et al. (2015) describe cadaveric tentorial and petroclinoid dural attachments, including variation in ossification. These connect the sphenoid with the meningeal framework but do not quantify a jaw-to-dura-to-sacrum force pathway or establish a craniosacral rhythm.

Developmental junctions and limits of the cranial-motion interpretation

The spheno-occipital synchondrosis is a cartilaginous growth junction between sphenoid and basiocciput that becomes a synostosis after fusion. Human computed-tomography studies show stage- and sex-related maturation rather than one exact age threshold (Lottering et al., 2015). Spheno-occipital junction is used when fusion status is unspecified; a fused adult junction is not treated as a mobile symphysis.

Cranial sutures, fontanelles, and synchondroses differ in tissue type and developmental role. Their compliance and load-related deformation must be distinguished from proposed palpable cranial-motion cycles. Sutural strain during mastication has been recorded in miniature swine, not demonstrated as a human PRM (Sun et al., 2004). Anatomical inclusion neither makes every growth junction a clinically testable AxCFU nor makes loss of a presumed rhythm an AxB criterion.

Defining Characteristics

- pelvic ring as the caudal structural region and load-transfer interface;
- vertebral column as the central longitudinal component but not the complete AxO;
- rib cage as an integral thoracic component, including its anterior and posterior articulations;
- cervico-cranial junction as the transition from the mobile vertebral column to the cranium;
- occipital bone—most directly its basioccipital and condylar components—as the rostral osseous continuation of the vertebral axis;
- entire skull as the cranial structural region, with paired TMJ-centered AxCFUs and specific sphenoidal muscular and meningeal relationships;
- distinction between functional inclusion, embryological origin, and age-dependent sutural or synchondral state; and

- regional overlap at transitional structures, particularly the sacrum, superior thoracic aperture, and occiput.

Statement 4. Superior Thoracic Aperture (Thoracic Inlet)

Primary Definition

*The **superior thoracic aperture** is the oblique osseocartilaginous opening bounded posteriorly by the body of T1, laterally by the first ribs and their costal cartilages, and anteriorly by the superior border of the manubrium. Within the AxO, the anatomical aperture together with its immediately adjacent three-dimensional soft-tissue zone is defined as a key cervicothoracic regional subsystem linking the cervical spine, first ribs, manubrium, upper thoracic cage, hyoid–laryngeal complex, respiratory structures, and shoulder-girdle boundary interfaces.*

Commentary

The aperture slopes anteroinferiorly. Radiological thoracic-inlet anatomy also encompasses a short three-dimensional zone spanning the lower infrahyoid neck and superior mediastinum (Obuchowski & Ortiz, 2000). The aperture and surrounding zone are distinguished here.

The oblique UTA and C7–T1 vertebral transition overlap but are not one horizontal plane. A transverse T1 section samples the junctional zone rather than the entire aperture. Sectional illustrations need a stated level and orientation, preferably with a localizer or adjacent sections (Connolly & Auchincloss, 2021; Obuchowski & Ortiz, 2000).

Thoracic inlet commonly denotes the superior thoracic aperture in anatomy and radiology. The clinical thoracic outlet is broader: the scalene triangle, costoclavicular space, and subcoracoid/pectoralis-minor space form a cervicoaxillary corridor extending toward the shoulder and upper limb (Connolly & Auchincloss, 2021).

The first rib develops from the T1 costal process and joins the manubrium. Costovertebral, costotransverse, intervertebral, and first sternocostal articulations organize several AxCFUs within the cervicothoracic subsystem (Connolly & Auchincloss, 2021).

Scalenes link cervical vertebrae to the first two ribs and help elevate the upper thoracic cage. Infrahyoid and laryngeal suspensory tissues extend toward the sternum and clavicular region. Deep cervical, prevertebral, endothoracic, and suprapleural fasciae meet around the pleural cupula. The suprapleural membrane is a dome-shaped condensation with associated bands, not a transverse sheet closing the aperture (Connolly & Auchincloss, 2021; Gaughran, 1964;

Miyake et al., 2011). Miyake et al.'s histology of 18 fetuses documents developmental anatomy, not mature mechanics or a functional diaphragm.

The trachea, esophagus, lung apices, pleural cupulae, major vessels, thoracic duct, and neural structures occupy or traverse this transition. Passage alone does not establish core membership. Statement 6 includes the proximal airway framework by its axial role, while excluding the lumen and remaining respiratory system from the core.

The inferior cervical or fused cervicothoracic (stellate) sympathetic ganglion varies in formation, shape, and level. Rusu et al. (2025, Figures 1, 2, 4, and 7) show it near the first-rib neck, lateral to longus colli and posterior to the vertebral artery. Kiray et al. (2005) also document variable ganglion configurations and longus-colli relations. The ansa subclavia connects cervical sympathetic ganglia around the subclavian artery (Loukas et al., 2008). These observations map neural–vascular–skeletal interfaces; they do not establish mechanically induced autonomic dysfunction.

The right recurrent laryngeal branch loops around the right subclavian artery; the left loops around the aortic arch farther caudally (Rusu et al., 2025). These are mixed pathways, with laryngeal motor function demonstrated by intraoperative stimulation (Kandil et al., 2011), not a uniform parasympathetic compartment. Their proximity does not incorporate the whole vagus, cardiac plexuses, or visceral targets into AxO, or establish an AxB-induced autonomic syndrome.

Clavicles, sternoclavicular joints, scapulae, and upper limbs influence geometry and loading, particularly in costoclavicular and lateral outlet spaces, while remaining boundary interfaces.

The osteopathic thoracic-inlet diaphragm is a functional metaphor for the muscles, fasciae, membranes, and neurovascular–visceral structures that cross and reinforce this transition, not a single anatomical membrane.

Table 2. Terminological distinctions at the superior thoracic aperture

Term	Usual anatomical or disciplinary scope	Relationship to AxO	Required distinction
Superior thoracic aperture (apertura thoracis superior)	Osseocartilaginous opening formed by T1, first ribs/costal cartilages, and superior manubrium	Core cervicothoracic AxO transition	The strict anatomical aperture; not the whole shoulder-to-axilla corridor.
Thoracic inlet	Anatomical/radiological synonym, sometimes extended to the lower-neck/superior-mediastinal zone	Source-dependent scope.	Define whether an opening or surrounding zone is meant.
Clinical thoracic outlet	Scalene triangle, costoclavicular space, and subcoracoid/pectoralis-minor space extending toward the axilla	Intersects AxO at the first-rib/cervicothoracic region and continues into boundary interfaces	Broader and more lateral than the superior thoracic aperture.
Thoracic-inlet diaphragm (osteopathic)	Functional treatment construct emphasizing regional muscular and fascial relations	Historical recognition of the junctional region.	Functional metaphor, not a continuous anatomical diaphragm.

Defining Characteristics

- an oblique osseocartilaginous opening bounded by T1, the first ribs and their costal cartilages, and the superior manubrium;
- the aperture’s plane distinguished from the surrounding three-dimensional transition zone;
- cervical, vertebrocostal, sternal, respiratory, and hyoid–laryngeal relationships;
- multiple interacting AxCFUs within one regional subsystem;
- passage and interface for pleural, visceral, vascular, lymphatic, and neural structures;

- mechanical coupling with the shoulder girdle across a retained boundary; and
- distinction from both the broader clinical thoracic outlet and a literal unitary thoracic-inlet diaphragm.

Statement 5. Component Classes and Boundary Interfaces

Primary Definition

Structures and regions related to the AxO *are classified as core axial osseous-articular components, articulation-centered AxCFUs, regional subsystems and transition complexes, suspended functional components, shared airway-related cartilaginous and connective-tissue components, active neuromuscular and pressure-regulating effectors, peripheral somatic and autonomic neural components, force-transmitting and sensory connective tissues, the craniospinal meningeal subsystem, or boundary interfaces. Mechanical influence across an interface does not by itself make the external structure part of the AxO.*

Commentary

A tissue may serve several units or systems. Its inclusion and its mechanical, sensory, or regulatory role are separate questions.

The osseous-articular core, articulation-centered AxCFUs, and regional subsystems describe different scales of organization. The craniomandibular apparatus, UTA, and CCJ each combine units and connecting tissues. Suspended components such as the hyoid and active effectors are classified by roles not captured by this joint-centered hierarchy.

Postural musculature is defined functionally rather than as a particular anatomical class. Inclusion as an AxO effector requires a direct contribution to orientation, stabilization, movement, pressure regulation, or adaptation to load—not merely depth or a traditional postural designation. Sustained tonic/isometric and phasic activity may occur separately or together, depending on the task (Frank et al., 2013; Hodges & Gandevia, 2000a; Hodges et al., 2007).

Masticatory and other participating orofacial muscles qualify through their craniomandibular motor roles, not by being relabeled as postural muscles. Their activity interacts with cervical and hyoid recruitment (Eriksson et al., 1998, 2000; Hellmann et al., 2012).

The diaphragm, abdominal wall, and pelvic floor are shared tissues whose axial-control and pressure-regulating roles belong to AxO. Their other respiratory, abdominal, or pelvic functions remain outside that classification.

Thyroid and cricoid cartilages and proximal tracheal cartilage and connective tissue form a proposed shared airway category. Their axial relationships are specified in Statement 6; they neither extend the osseous-articular core nor automatically create an AxCFU.

Direct neural supply includes motor and sensory branches, articular and sinuvertebral pathways, postganglionic sympathetic fibers, perivascular plexuses, and participating portions of rami communicantes, trunks, and ganglia (Civelek et al., 2008; Groen et al., 1990; Rutter et al., 2017). Central regulators are outside the AxO. Enteric circuits and unrelated visceral targets are excluded by functional scope, not by the central–peripheral distinction.

Fasciae, aponeuroses, ligaments, capsules, and discs transmit and constrain force, store elastic energy, and have region-specific sensory roles. Craniospinal dura has focal cranial-base, sphenoidal, occipital, vertebral, ligamentous, and myodural interfaces. Shoulder-girdle, hip-joint, and limb relationships cross the AxO boundary; particular shared tissues may still qualify by role.

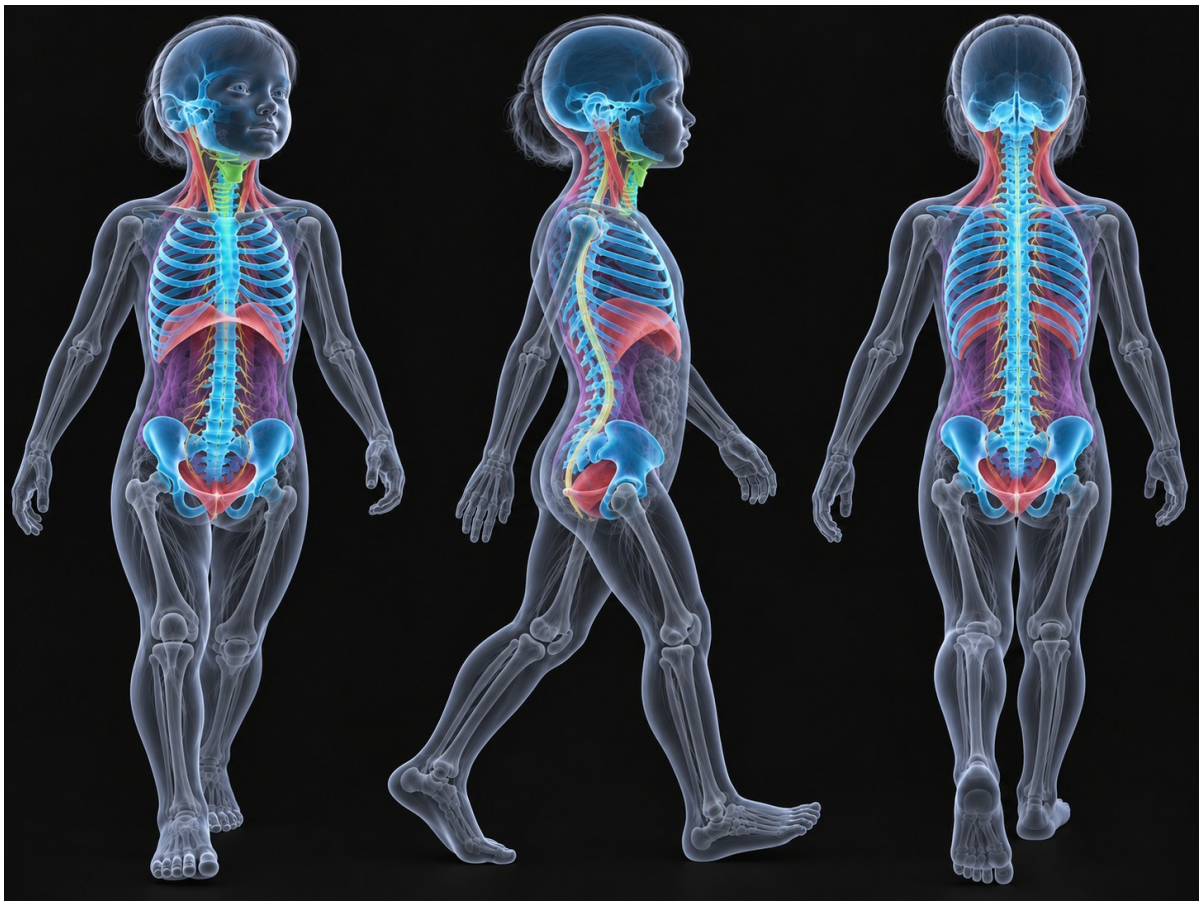

Figure 1. Selective anatomical organization of the Axial Organ (AxO) in a pediatric movement context.

Anterior-oblique (left), lateral (centre), and posterior (right) views show selected components within a translucent body. Cyan marks osseous-articular structures, including visible mandibular anatomy; red/pink, muscular and pressure-regulating components; purple, connective-tissue continuity; green, hyoid-associated and shared cervical–cervicothoracic airway structures; yellow, schematic peripheral nerves. The entire skull is included, although the sphenoid, TMJ discs and capsules, sutures, and other fine cranial structures are unresolved. Color intensity or absence does not define membership; Table 3 provides the classification. Shoulder-girdle and femoral structures give boundary context; brain and spinal cord remain external regulators. Poses illustrate movement, not measured gait, synchronized phases, or age-specific norms. Fine articular, vascular, meningeal, and neural anatomy and segmental counts are not validated. The artificial-intelligence-generated base received targeted boundary-color corrections and airway overlays; it is not a patient image or imaging reconstruction.

Table 3. Proposed classification of AxO components and interfaces

Class	Included examples	Basis for classification	Principal boundary rule
Core axial osseous-articular components	Pelvic ring; vertebral column; ribs, costal cartilages, sternum and articulations; superior thoracic aperture ring; CCJ; entire skull, including sphenoid and mandible	Continuous structural framework of the body axis	Included in the structural core.
Articulation-centered AxCFUs	Sacroiliac joints (SIJs), pubic symphysis, intervertebral and zygapophyseal joints, costovertebral/costotransverse joints, sternocostal region, CCJ articulations, and each TMJ	Complete functional complex centered on one articulation	Sutures and growth junctions are not automatically clinically testable AxCFUs.
Regional subsystems and transition complexes	Lumbosacral/pelvic, superior-thoracic-aperture, cervico-cranial, craniomandibular, and hyoid–laryngeal regions	Several AxCFUs, core structures, effectors, connective tissues, and interfaces in one region	Multiple units and non-articulating tissues; paired TMJ coupling does not imply pathology.
Suspended functional component	Hyoid complex and its suspensory musculoligamentous relationships	Mechanical and sensorimotor coupling without a conventional bony articulation	Suspended component, not an AxCFU.
Shared airway-related cartilaginous and connective-tissue components	Thyroid and cricoid cartilages; participating laryngeal membranes and suspensory tissues; cervical tracheal cartilage and inter-ring connective tissue; immediately cervicothoracic continuation.	Axial roles in hyoid coupling, cervical configuration, respiratory mechanics, and the UTA region.	Shared by role, not core or an automatic AxCFU; no distal trachea, carina, bronchi, or lungs by continuity alone.

Class	Included examples	Basis for classification	Principal boundary rule
Active neuromuscular and pressure-regulating effectors	Axial skeletal muscles; masticatory and directly participating orofacial, suboccipital, scalene, hyoid, thoracic, abdominal, diaphragmatic, and pelvic-floor musculature	Neurally controlled tonic/isometric and phasic force, movement, stiffness, and respiratory or abdominopelvic pressure	Only axial functions qualify; depth or a postural label is insufficient.
Peripheral somatic and autonomic neural components	Cranial and spinal peripheral motor/sensory supply to included tissues; articular and sinuvertebral branches; postganglionic sympathetic fibers; perivascular plexuses; AxO-directed portions of rami communicantes, trunks, and ganglia	Direct motor, sensory, nociceptive, vasomotor, trophic, or other demonstrated neural roles	Central regulators remain outside AxO; shared pathways qualify only through AxO-directed supply and function.
Force-transmitting and sensory connective tissues	Fasciae, aponeuroses, ligaments, capsules, tendinous expansions, intervertebral and TMJ discs; cranial sutural and synchondral tissues in their developmental context	Force transmission, distribution, and constraint; elastic-energy storage; region-specific mechanosensory and nociceptive signaling	Regional material and sensory evidence required; sutural compliance does not establish PRM or diagnostic motion patterns.
Craniospinal meningeal subsystem	Cranial and spinal dura; cranial periosteal-dural and sphenoidal/clinoid interfaces; myodural bridges; meningovertebral ligaments	Internal meningeal continuity with focal osseous, ligamentous, and muscular attachments and sensory innervation	Not an AxCFU; local attachments do not imply unrestricted craniosacral force transmission.

Class	Included examples	Basis for classification	Principal boundary rule
Boundary interfaces	Sternoclavicular joints, clavicles and scapulae; hip joints; limbs	Exchange of mechanical forces and sensorimotor information with AxO	Influence does not by itself establish inclusion in the AxO core.

Abbreviations: CCJ, cervico-cranial junction; PRM, primary respiratory mechanism; SIJ, sacroiliac joint (plural SIJs); TMJ, temporomandibular joint (plural TMJs).

Defining Characteristics

- classification according to role rather than proximity alone;
- distinct structural, local-unit, regional, suspended, active, neural, connective-tissue, meningeal, and boundary classes;
- muscles, fasciae, ligaments, dura, vessels, and peripheral pathways crossing regional, AxCFU, and system boundaries;
- functional classification of postural muscles and role-specific inclusion of tissues shared with other systems; and
- boundaries broader than the vertebral column but narrower than the whole body.

Statement 6. Hyoid Complex and Cervical–Cervicothoracic Airway Framework

Primary Definition

*The **hyoid complex** is a suspended functional component of the AxO because of its muscular, fascial, ligamentous, and sensorimotor coupling with cranial, mandibular, cervical, laryngeal, sternal, and shoulder-girdle regions. The hyoid itself is not an articulation-centered AxCFU. The laryngeal cartilaginous framework, particularly the thyroid and cricoid cartilages, and the cervical–cervicothoracic tracheal cartilaginous and connective-tissue framework are included as shared airway-related components in their directly contributing axial roles. This inclusion is primarily cervical and extends only into the immediately adjacent cervicothoracic junctional zone. It does not extend the osseous-articular core, classify the whole complex as an AxCFU, or incorporate the complete respiratory system.*

Commentary

Supra- and infrahyoid muscles, ligaments, and fasciae suspend the hyoid. Cranial-base and mandibular attachments link included AxO structures; inferior relations extend to the larynx and sternum. Omohyoid and cervical fasciae connect to the shoulder-girdle boundary. Lingual and pharyngeal participation depends on the specific motor role.

Mortensen et al. (2018) improved simulated neck flexion by adding hyoid-muscle actuators. Attachment motion was coupled to cervical segments and dynamic input came from one adult, limiting inference about independent hyoid movement and pediatric function. Surface EMG separately demonstrates position-dependent supra- and infrahyoid activity during cervical flexion (Sageshima et al., 2022).

Rocabado (1983) proposed coordinated cranial, cervical, and hyoid assessment. Valenzuela et al. (2005) found no significant association of head-posture group with hyoid position or sternocleidomastoid activity in 50 young adults. Sağlam and Uydas (2006) found sex-related hyoid-position differences in 76 adult cephalograms without corresponding differences in natural head position. These findings do not establish a fixed posture-to-displacement rule.

Hyoid-complex disturbances may interact with neighboring AxCFUs but require separate description: the non-articulating hyoid cannot itself meet the AxB definition.

Shared laryngeal and proximal tracheal framework

Cervical configuration and respiratory conditions can alter the mechanical state of the hyoid–laryngeal apparatus and its tracheal continuation (Kohno et al., 2019; Wong et al., 2008). This motivates the shared category specified above.

The distal boundary follows the cervical segment into the adjacent cervicothoracic zone around the UTA, rather than a fixed tracheal-ring number. The remaining intrathoracic trachea, carina, bronchi, and lungs are excluded unless a separate AxO-directed role is established.

In 20 anaesthetized adults, Wong et al. (2008) found that the vocal-cord-to-sternal-notch segment accounted for most airway length change during neck extension; the sternal-notch-to-carina segment did not change significantly. Safshekan et al. (2016) found different mechanical properties in cartilage, connective tissue, and smooth muscle from 30 human tracheas. Kohno et al. (2019) found hyoid-position changes with muscle paralysis and lung-volume manipulation in adult men. These adult findings support posture-sensitive airway mechanics and hyoid–respiratory coupling, not a universal tracheal stabilization mechanism or pediatric norms.

Cartilage and connective tissue form the deformable framework; adjacent supra- and infrahyoid skeletal muscles generate active force. Trachealis is smooth muscle. Unlike the hyoid, some laryngeal structures articulate, but inclusion does not automatically classify those articulations as AxCFUs or mobility findings as AxB.

Clinical motivation and scope. The corresponding author's manual work with the hyoid and major laryngeal cartilages prompted this classification. Efficacy, safety, mechanism, and diagnostic validity require independent study. Techniques, contraindications, competencies, and validation belong in separate methodological papers.

Defining Characteristics

- suspension without conventional bony articulation;
- muscular and fascial relationships spanning cranial, mandibular, cervical, laryngeal, sternal, and shoulder-girdle regions;
- demonstrated contribution of hyoid musculature to head-and-neck motor control;
- functional inclusion without classification as an AxCFU;
- major laryngeal cartilages and cervical–cervicothoracic tracheal tissues included by axial role; and
- postural and remote effects requiring evidence beyond anatomical linkage.

Statement 7. Active Force Generation and Closed-Loop Sensorimotor Architecture of the AxO

Primary Definition

*The **AxO** operates as a closed-loop sensorimotor architecture in which neurally controlled skeletal muscle generates intrinsic axial force through sustained tonic/isometric stabilization and task-related phasic activity; the thoracic diaphragm, abdominal wall, and pelvic floor additionally regulate respiratory and abdominopelvic pressure; articulations, intervertebral discs, joint capsules, ligaments, fasciae, shared airway connective tissues, and focal meningeal attachments transmit, distribute, and constrain these forces together with gravitational, inertial, external, contact, respiratory, and pressure-related loads, storing elastic energy during deformation; loading of innervated tissues can modify afferent signaling according to their sensory properties; and segmental and suprasegmental integration updates motor output,*

thereby producing the subsequent mechanical state of the AxO. Coupling is graded, regionally heterogeneous, and history-dependent and does not imply uniform or inevitable remote effects.

Commentary

Pelvic, thoracic, cervicothoracic, and CCJ components interact through articulations, ligaments, muscle attachments, and force-transmission interfaces. Regional geometry and material properties constrain this coupling (Connolly & Auchincloss, 2021; Liebsch et al., 2017; Liebsch & Wilke, 2022; Vleeming et al., 2012; Zhuang et al., 2022).

Active effector denotes skeletal muscle's capacity for sustained tonic/isometric and phasic force generation under neural drive. Connective tissues participate through mechanics and sensory return (Bolaños & Calderón, 2022; Riemann & Lephart, 2002). Willard et al.'s (2012) lumbopelvic account supplies this organizing principle, not a geometry assumed to repeat throughout the AxO.

Krause et al. (2016) reviewed human in-vivo and in-vitro force-transfer evidence along selected myofascial chains. Wilke et al. (2018) synthesized animal, cadaveric, and early in-vivo findings, noting uncertainty about force magnitude and central contributions to remote exercise effects. These reviews support pathway-specific study rather than a purely peripheral explanation of every nonlocal response.

Coupling depends on posture, load, muscle activity, respiration, joint geometry, tissue stiffness, force direction and rate, timescale, and available compensatory movement. A perturbation may remain local, be absorbed, alter adjacent loading, or reach a distant region with attenuation. Measurement must distinguish these outcomes (Barker et al., 2004; Kellis et al., 2024; Mohr et al., 2023).

Central autonomic output reaches AxO tissues through peripheral pathways alongside somatic force generation. Sympathetic fibers in selected fasciae plausibly regulate vascular and local tissue conditions (Fede et al., 2022; Mense, 2019). Effects on bulk fascial mechanics remain a separate question addressed in Statement 8 and Table 4.

Afferent integration updates motor output, which changes muscle force, pressure, joint relations, and connective-tissue loading (Riemann & Lephart, 2002; Sousa et al., 2012). Figure 2 separates physical tissue state, sensory sampling, and neural regulation; it does not assign primary and secondary causes.

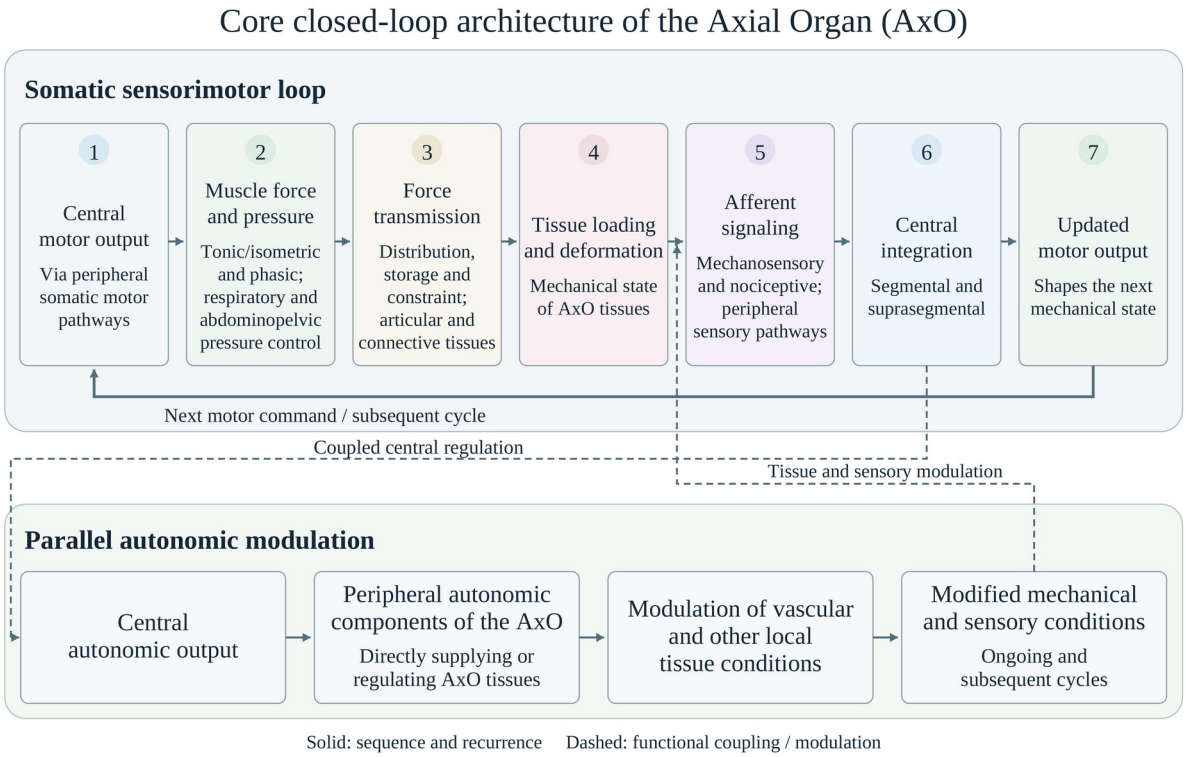

Figure 2. Core closed-loop architecture of the Axial Organ (AxO).

Seven stages connect motor output, muscle-force and pressure generation, force transmission, tissue loading, afferent signaling, central integration, and renewed output. Connective structures include discs, capsules, ligaments, fasciae, and focal meningeal interfaces. Storage denotes elastic energy. The return line indicates recurrence, not another tract. Dashed connectors distinguish coupled central regulation from peripheral modulation of tissue and sensory conditions during ongoing and subsequent cycles. External loads and additional sensory inputs are omitted.

Brain and spinal cord regulate from outside the AxO; included peripheral pathways directly supply its tissues. Regional evidence determines sympathetic or parasympathetic participation without incorporating enteric circuits or unrelated viscera. Starting at motor output is a display convention, not developmental or causal priority. The schematic is not a validated quantitative model; neither uniform coupling nor equivalence of altered input with Persistent Afferent Bias (PAB) is implied.

Defining Characteristics

- neurally controlled tonic/isometric and phasic skeletal-muscle force, respiratory and abdominopelvic pressure regulation, and gravitational, inertial, external, and contact loads;
- force transmission and constraint, with elastic-energy storage during deformation of articulations, discs, capsules, ligaments, fasciae, and focal meningeal attachments;
- loading-related afferent changes in innervated tissues, with modality established functionally;
- segmental and suprasegmental integration that updates motor output and produces the subsequent AxO state;
- graded, heterogeneous, history-dependent coupling; remote effects require pathway-specific evidence.

Statement 8. Fascial and Meningeal Integration of the AxO

Primary Definition

*Within the AxO, **fasciae and the craniospinal dura mater** are anatomically distinct, non-phasic connective-tissue components embedded within the closed-loop sensorimotor architecture. Fasciae provide region-specific pathways for force transmission, distribution, and constraint, elastic energy storage, and sensory signaling; the craniospinal dura forms an internal meningeal continuum with localized cranial, vertebral, ligamentous, and myodural attachments. Neither tissue is a rapid motor effector. Their mechanical state is generated principally by skeletal-muscle activity, joint and pressure conditions, external loading, and material properties; local deformation may contribute to mechanosensory or nociceptive afferent signaling, and autonomic fibers are acknowledged where directly demonstrated without inferring that fascia constitutes a distinct interoceptive organ.*

Commentary

Deep, muscular, aponeurotic, and superficial fasciae relate to muscle, vessels, and adipose tissue; craniospinal dura encloses the central nervous system. They differ in histology, mechanics, attachments, and innervation and remain distinct within AxO (Cavelier et al., 2023; Fede et al., 2022; Pirri et al., 2024; Zhuang et al., 2022).

Skeletal-muscle excitation–contraction coupling generates Ca^{2+}-dependent cross-bridge force under α-motor-neuron control. Fasciae and dura lack this rapid neuromuscular architecture. Their deformation under muscle, joint, pressure, gravitational, inertial, contact, and other loads may affect sensory return without independently commanding movement (Bolaños & Calderón, 2022; Hoppe et al., 2014).

Human myofascial junctions show type I and III collagen and hyaluronan immunoreactivity with elastic fibers (Pirri et al., 2024). Cadaveric loading demonstrates tension beyond the loaded muscle (Barker et al., 2004). In living humans, Mohr et al. (2023) found knee-angle-dependent calf–hamstring displacement during passive ankle motion, with surface EMG screening the recorded muscles; displacement was an indirect force-transfer measure. Kellis et al. (2024) found position- and active/passive-state-dependent thoracolumbar-fascial shear-wave modulus. These methods measure different aspects of regional mechanics, not unrestricted long-range force propagation.

Human epi-, peri-, and endomysial fasciae contain cells positive for α-smooth muscle actin (α-SMA) consistent with myofibroblasts. Hoppe et al. (2014) found no significant contraction after electrical stimulation of 25 mouse fascial preparations. Pharmacological responses were sparse and slow in limited human material and more systematic in animal preparations. Schleip et al. (2019) measured regional differences in human myofibroblast density but used rat fascia for mechanography and extrapolated human lumbar-fascial forces. Responses took minutes to hours; estimated forces were at least two orders below skeletal-muscle force and below the cited stabilization requirement. Possible effects concern long-term prestress, stiffness, contracture, or remodeling, not phasic motor action.

In human superficial abdominal and hip fascia, Fede et al. (2022) found neural structures immunoreactive for protein gene product 9.5 (PGP9.5) and S100. Tyrosine-hydroxylase (TH) immunoreactivity occurred around vessels and in connective and adipose regions; no corpuscular sensory endings were identified in those samples.

Yahia et al. (1992) identified free endings and Ruffini- and Vater–Pacini-type structures in thoracolumbar-fascial surgical specimens from seven patients. Stecco et al. (2007) found regionally distributed free and encapsulated endings in deep fascia from 20 upper limbs. These morphological findings support sensory hypotheses, not measured proprioceptive function; limb fascia provides a comparator rather than extending the AxO boundary.

Using immunohistochemistry and electron microscopy in seven male mice, Fede et al. (2021) found different neural densities and organization in thoracolumbar and gluteal fasciae. Regional mouse networks do not establish an autonomous fascial controller or uniform human proprioception.

Sakamoto et al. (2026) found peripherin-positive unmyelinated fibers in crural fascia from 16 lower legs of eight Thiel-embalmed cadavers. This extra-axial sample establishes neural presence, but peripherin does not distinguish nociceptive, autonomic, or other sensory functions.

In trapezius fascia from 18 occipital-neuralgia patients and 10 controls, Tereshenko et al. (2026) identified Piezo2-negative corpuscle-like endings. Calcitonin gene-related peptide (CGRP) and TH labeling varied by group. Morphology and immunoreactivity support candidate sensory or autonomic roles, not direct receptor physiology or demonstrated proprioception or interoception.

Mense's (2019) mainly rat-based review describes free endings, low mechanical thresholds, neuropeptide-positive fibers, and postganglionic sympathetic fibers in thoracolumbar fascia. Suarez-Rodriguez et al. (2022) combine studies across species, regions, and markers, assigning proprioceptive roles to some endings. Such anatomical assignments remain distinct from functional testing; the evidence provides no uniform fascial receptor map.

Fascial mechanosensory input may contribute to proprioceptive state estimation and protective motor regulation. Nociceptive input can arise under potentially harmful mechanical, chemical, or inflammatory conditions. Human thoracolumbar-fascial stimulation evokes pain with spatial, temporal, and qualitative features different from muscle or subcutaneous stimulation (Schilder et al., 2014, 2018). TH labeling, by contrast, supports sympathetic/catecholaminergic participation rather than an interoceptive afferent code or central projection (Fede et al., 2022; Tereshenko et al., 2026).

Autonomic innervation does not itself establish control of fascial mechanics. Brandl et al. (2024) followed one adult athlete for 30 days and found time-dependent associations between heart rate variability (HRV) and ultrasound-measured thoracolumbar-fascial deformability. The observational design and indirect autonomic indices establish an exploratory association, not a specific mechanism or treatment effect.

L. A. Hack and Porges (2026) propose that fascial afference informs central state regulation while autonomic output shapes the local physiological environment, rather than a direct fascia–

autonomic circuit. Their keynote synthesis and edited interview offer a conceptual interpretation, not primary evidence of a fascial interoceptive organ, vagal fascial pathway, or treatment effects.

At the CCJ, sheet plastination shows fibers from cranial dura, foramen-magnum periosteum, and myodural tissue contributing to posterior cervical spinal dura (Zhuang et al., 2022). Human tensile testing shows region- and direction-dependent properties (Cavelier et al., 2023). These findings describe a heterogeneous meningeal subsystem.

Cadaveric and histological studies identify bridges from rectus capitis posterior minor (RCP minor), rectus capitis posterior major (RCP major), and obliquus capitis inferior (OCI) to upper cervical dura through posterior atlanto-occipital or atlantoaxial regions. Cadaveric testing supports a role for the RCP minor–connective-tissue complex in limiting inward dural displacement during extension. Headache, cerebrospinal-fluid effects, and remote craniosacral behavior remain hypotheses beyond this local coupling (G. D. Hack et al., 1995; Humphreys et al., 2003; Pontell et al., 2013; Scali et al., 2011; Venne et al., 2017).

Upper-cervical meningomyovertebral structures and lumbar meningovertebral ligaments attach outer dura to ligamentous and osteofibrous canal boundaries. Their variable distribution indicates focal rather than uniform fixation (Geers et al., 2003; Scali et al., 2015).

Groen et al. (1988) mapped denser ventral than dorsal dural innervation in four human fetuses using acetylcholinesterase staining. Kallakuri et al. (1998) found neuropeptide- and TH-reactive fibers in lumbar dura and longitudinal ligaments of New Zealand White rabbits. Neither study measured receptor responses or established uniform human dural proprioception or interoception.

In 11 formaldehyde-fixed cadavers, mean age 82 years, cervical movement produced frontal and parietal dural length changes below measurement accuracy (Feipel et al., 2003). This limits assumptions of unattenuated transmission under those conditions, not the possibility of strain in living children or local myodural effects.

Table 4 separates the observed tissue properties from their AxO interpretation. In the loop shown in Figure 2, these tissues transmit and constrain load and provide region-specific sensory input; autonomic pathways modulate local vascular and tissue conditions.

Table 4. Evidence hierarchy for fascial and meningeal integration within the AxO

Domain	Directly supported proposition	AxO interpretation	Principal evidential boundary
Neurally controlled skeletal-muscle force generation	Excitation–contraction coupling generates Ca^{2+}-dependent muscle force for sustained tonic/isometric and phasic activity (Bolaños & Calderón, 2022).	Principal intrinsic active force generator.	Physiological synthesis, not an AxO experiment; task-dependent activity does not account for every load.
Human myofascial junction	Human muscle–fascia junctions show type I/III collagen and hyaluronan immunoreactivity with elastic fibers (Pirri et al., 2024).	Anatomical muscle–fascia interface.	Anatomical interface does not quantify whole-system force or remote clinical effects.
Regional in-vivo myofascial mechanics	Living-human studies show knee-angle-dependent thigh–calf displacement and state-dependent thoracolumbar-fascial shear-wave modulus (Kellis et al., 2024; Mohr et al., 2023).	State- and pathway-dependent mechanics.	Displacement and modulus are indirect measures, not proof of unrestricted force transfer.
Human fascial α-SMA-positive cells	α-Smooth-muscle-actin-positive cells consistent with myofibroblasts occur in human epi-, peri-, and endomysial fascia and differ among fascial regions (Hoppe et al., 2014; Schleip et al., 2019).	Possible slow cellular effects on prestress or remodeling.	Cell presence does not establish phasic motor output, physiological activation, or clinically meaningful in-vivo force.

Domain	Directly supported proposition	AxO interpretation	Principal evidential boundary
Slow pharmacological fascial tension	Limited human material showed sparse, slow pharmacological responses; systematic mechanography used rat fascia (Hoppe et al., 2014; Schleip et al., 2019).	Possible minutes-to-hours modulation of tissue tone, stiffness, contracture, or remodeling.	Distinct from twitch/tetanus. Electrical nonresponse was tested in mice; human force estimates were extrapolated from rats.
Thoracolumbar-fascial sensory and sympathetic innervation	Mense's (2019) mainly rat-based review reports free endings as the only receptive endings in examined samples, low thresholds, CGRP/substance-P profiles, and postganglionic sympathetic fibers.	Regional sensory and autonomic participation.	Mostly animal evidence. Low threshold does not prove proprioception; possible vasoconstrictor fibers do not establish interoceptive afference.
Human superficial-fascial innervation and autonomic fibers	PGP9.5-, S100-, and TH-positive neural structures were identified around vessels and within connective and adipose regions of human superficial fascia (Fede et al., 2022).	Regional neural and catecholaminergic participation.	Small regional sample; TH labeling establishes neither interoceptive coding nor universal sympathetic distribution.

Domain	Directly supported proposition	AxO interpretation	Principal evidential boundary
Human crural-fascial unmyelinated fibers	Peripherin-positive unmyelinated fibers occurred in all examined human crural-fascial specimens, with regional differences (Sakamoto et al., 2026).	Unmyelinated fibers with regional variation.	Peripherin is not modality-specific. Sixteen legs from eight Thiel cadavers provide extra-axial evidence.
Human trapezius-fascial neural profiles and receptor-like endings	Trapezius fascia from 18 occipital-neuralgia patients and 10 controls contained myelinated and unmyelinated axons, CGRP/TH labeling, and corpuscle-like endings. The identified endings were Piezo2-negative (Tereshenko et al., 2026).	Clinical-state-dependent profiles and candidate sensory endings.	No receptor-physiology test; morphology and markers establish neither proprioception nor interoception.
Human fascial nociception	Controlled thoracolumbar-fascial stimulation produces pain differing from muscle or subcutaneous-tissue stimulation (Schilder et al., 2014, 2018).	Nociceptive contribution in the tested fascia.	No universal pain behavior or direct proprioceptive test.
Preliminary autonomic–fascial association	In a 30-day single-participant series, selected HRV indices covaried with ultrasound-measured thoracolumbar-fascial deformability (Brandl et al., 2024).	Exploratory within-person association requiring controlled testing.	One participant, once-daily sampling, indirect autonomically non-specific HRV indices; no causal mechanism established.

Domain	Directly supported proposition	AxO interpretation	Principal evidential boundary
Craniovertebral dural continuity and mechanics	Cervical spinal dura contains fibers continuous with cranial dura, foramen-magnum periosteum, and myodural tissue; human spinal dura has region- and direction-dependent tensile properties (Cavelier et al., 2023; Zhuang et al., 2022).	Mechanically responsive meningeal subsystem.	No uniform cable or demonstrated craniosacral rhythm.
Myodural interfaces	RCP minor, RCP major, and OCI connective-tissue bridges to cervical dura are anatomically demonstrated; local biomechanical function has experimental support (G. D. Hack et al., 1995; Humphreys et al., 2003; Pontell et al., 2013; Scali et al., 2011; Venne et al., 2017).	Local route linking muscle force to dural geometry or tension.	Clinical effects and remote consequences remain incompletely established.
Meningovertebral anchoring	Upper-cervical and lumbar connective-tissue bands attach dura to vertebral-canal boundaries (Geers et al., 2003; Scali et al., 2015).	Focal constraints on dural mechanics.	Variable distribution, not uniform fixation.
Dural sensory innervation	Human fetal staining mapped denser ventral than dorsal dural nerves (Groen et al., 1988). Rabbit immunohistochemistry identified neuropeptide- and TH-reactive fibers in lumbar dura and longitudinal ligaments (Kallakuri et al., 1998).	Candidate sensory and autonomic substrate.	Fetal and rabbit anatomy, not receptor physiology or demonstrated uniform human proprioception or interoception.

Domain	Directly supported proposition	AxO interpretation	Principal evidential boundary
Long-range craniospinal transmission	Cervical movement produced frontal/parietal dural changes below measurement accuracy in 11 formaldehyde-fixed cadavers, mean age 82 (Feipel et al., 2003).	Unattenuated transmission cannot be assumed from continuity alone.	Fixation, age, sampled regions, and detection limits restrict inference to living or pediatric tissues.

Abbreviations: α-SMA, α-smooth muscle actin; CGRP, calcitonin gene-related peptide; PGP9.5, protein gene product 9.5; TH, tyrosine hydroxylase; HRV, heart rate variability; RCP minor, rectus capitis posterior minor; RCP major, rectus capitis posterior major; OCI, obliquus capitis inferior. S100 and Piezo2 are molecular marker names, not initialisms.

Defining Characteristics

- anatomical and functional distinction between fasciae and craniospinal dura mater;
- skeletal muscle, rather than fascia or dura, as the tonic/isometric and phasic force generator;
- regional transmission, distribution, and constraint of force, with elastic energy storage by connective tissues;
- heterogeneous mechanosensory and nociceptive roles, with autonomic fibers recognized where demonstrated;
- craniospinal meningeal continuity with focal cranial-base, sphenoidal, occipital, myodural, ligamentous, and vertebral attachment interfaces;
- possible slow myofibroblast effects on prestress, stiffness, contracture, and remodeling;
- modality-specific interpretation of neural markers; sympathetic fibers alone do not establish a fascial interoceptive organ; and
- pathway-specific evidence required for remote mechanical or craniosacral effects.

Statement 9. Neurophysiological Integration of the AxO

Primary Definition

*The **AxO** is neurophysiologically integrated through peripheral somatic and autonomic neural components that directly innervate or regulate its tissues, distributed afferent signaling from its*

articular, muscular, tendinous, ligamentous, fascial, meningeal, cutaneous, and other relevant sensory components, and segmental and suprasegmental sensorimotor and autonomic control. The brain, spinal cord, and central autonomic network provide central regulation but are not components of the AxO. Sensory modality must be specified where evidence permits, and the construct does not imply a single dedicated AxO neural pathway.

Commentary

Central regulation and peripheral neural inclusion. Acetylcholinesterase whole-mount studies in human fetuses map interconnected ventral and dorsal vertebral plexuses receiving sympathetic, communicating, perivascular, and sinuvertebral branches (Groen et al., 1990). Cervical and lumbar cadaveric studies locate sympathetic trunks near prevertebral muscles, fascia, vertebral bodies, and discs (Civelek et al., 2008; Rutter et al., 2017). These establish regional anatomy, not autonomic responses to AxB or manual intervention.

Shared peripheral pathways and the central boundary. AxO-directed supply is a functional criterion, not a claim of separable AxO-only fascicles or ganglia. Shared pathways may also serve visceral, vascular, cutaneous, or appendicular tissues. Evidence in musculoskeletal and connective tissues is predominantly sympathetic/catecholaminergic; parasympathetic, vagal, and pelvic-autonomic contributions require direct anatomical or regulatory evidence.

Recurrent laryngeal motor fibers supplying skeletal muscle are not parasympathetic effectors merely because they travel with the vagus (Kandil et al., 2011). The function of each participating branch must be distinguished from the nerve’s other targets.

TMJ, masticatory, and other cranial branches qualify by direct supply, without incorporating entire cranial nerves. Skeletal-muscle control includes branchial as well as spinal motor pathways; the associated brainstem nuclei remain central regulators.

Articular studies describe somatic and autonomic innervation (Samuel, 1952), mechanoreceptive endings, and sensory contributions to position and motion sensing, reflexes, and nociception (Riemann & Lephart, 2002; Zimny, 1988). Distribution and responses vary by tissue and joint.

Articular, muscular, and fascial afferents provide information about position, movement, muscle length and tension, deformation, loading, and nociceptive conditions. They combine with vestibular, visual, and cutaneous information to regulate tone, orientation, equilibrium, and movement. Meningeal contributions require separate functional evidence (Groen et al., 1988; Ivanenko & Gurfinkel, 2018; Riemann & Lephart, 2002; Sousa et al., 2012; Tesarz et al., 2011).

Pettorossi and Schieppati (2014) review experiments in which neck-muscle vibration alters body orientation, gait trajectory, subjective straight-ahead, and self-motion perception. These cervical proprioceptive–vestibular effects demonstrate a stimulus-specific regional influence, not an equivalent effect of every AxO disturbance.

Sensory weighting depends on region, tissue, modality, and task. The species-, layer-, and clinical-state differences reviewed in Statement 8 and Table 4 preclude treating the AxO as a homogeneous sensory channel (Fede et al., 2022; Groen et al., 1988; Mense, 2019; Sakamoto et al., 2026; Suarez-Rodriguez et al., 2022; Tereshenko et al., 2026).

Afferent signaling is used unless a modality is supported. Mechanosensory input may contribute to proprioception; nociceptive and autonomic labeling require separate interpretation. Dural mechanosensitivity and nociception remain functionally distinct from anatomical nerve detection. Sympathetic labeling and the polyvagal interpretation of L. A. Hack and Porges (2026) do not establish fascial interoception or a vagal pathway (Fede et al., 2022; Groen et al., 1988; Schilder et al., 2014, 2018; Tereshenko et al., 2026).

Defining Characteristics

- directly participating peripheral somatic and autonomic neural components supplying or regulating AxO tissues;
- distributed afferent signaling from articular, muscular, fascial, meningeal, and other axial tissues;
- brain, spinal cord, and central autonomic network as regulators outside the AxO;
- segmental and suprasegmental sensorimotor integration with central updating of motor output;
- interaction with vestibular, visual, cutaneous, and other sensory systems;
- task-, tissue-, modality-, and region-dependent sensory weighting; and
- shared pathways included only through AxO-directed supply, without a uniform fascial or dural sensory role.

Statement 10. Respiratory–Postural Coupling

Primary Definition

Respiratory–postural coupling within the AxO *is mediated by shared active neuromuscular and pressure-regulating components. The thoracic diaphragm, abdominal wall, and pelvic*

floor contribute to ventilation, respiratory and abdominopelvic pressure regulation, and task-dependent axial stabilization. The rib cage forms part of the structural core; these muscular structures are not core osseous-articular components or independent AxCFUs, and their inclusion is limited to their AxO-directed roles.

Commentary

Rib motion, sternal integrity, thoracic mechanics, muscle activity, and intra-abdominal pressure interact during breathing and movement. Scalenes link the cervical spine to the upper ribs (Connolly & Auchincloss, 2021). Diaphragm activation before rapid limb movement and continued modulation during repetitive tasks demonstrate shared respiratory and postural roles (Hodges et al., 1997; Hodges & Gandevia, 2000a).

Quadratus lumborum links the twelfth rib, lumbar transverse processes, and iliac crest through variable fascicles (Phillips et al., 2008). Serratus posterior inferior connects the lower ribs with the lower thoracic–upper lumbar region and contributes to the thoracolumbar fascia (Satoh, 1970; Willard et al., 2012). These connections do not establish a fixed antagonist to the scalenes: effects depend on recruitment and movement constraints. Attachments alone do not establish a respiratory action of serratus posterior inferior (Vilensky et al., 2001).

Diaphragmatic and abdominal co-activation contributes to pressure and trunk control. Increased respiratory demand can reduce the diaphragm's postural contribution, indicating competition for shared capacity (Hodges & Gandevia, 2000b; Hodges et al., 2001). Pelvic-floor activity also coordinates with respiration and posture (Hodges et al., 2007).

Abdominal-wall and pelvic-floor roles include axial stiffness, abdominopelvic pressure, pelvic-ring mechanics, and postural control (Hodges et al., 2007). The pelvic floor is distinct from the structural ring; only the shared tissues' axial functions are included.

Deep stabilization concepts and ISSS describe this muscular and pressure coordination; DNS applies developmental kinesiology to its assessment (Frank et al., 2013; Kobesova et al., 2020; Kolář & Lewit, 2005). Their clinical descriptions overlap with AxO but do not validate whole-AxO measures or specify its boundaries.

The diaphragm–abdominal wall–pelvic floor "canister" models regional pressure relationships, not a homogeneous chamber or complete AxO. Shared anatomy does not make every respiratory or pelvic-floor disorder an AxO disorder or justify one treatment sequence.

The proximal airway framework accommodates cervical–cervicothoracic motion (Statement 6); it does not replace the abdominopelvic pressure system. Its inclusion supplies no evidence that laryngeal manipulation alters ventilation or axial stability.

Defining Characteristics

- rib cage as both respiratory structure and structural AxO component;
- diaphragm, abdominal wall, and pelvic floor as shared active and pressure-regulating components;
- pressure-mediated contribution to axial stabilization;
- task-dependent sharing and possible competition between respiratory, postural, and pressure-regulating functions;
- pelvic floor distinct from pelvic ring, with only shared tissues' axial roles included;
- overlap, not equivalence, with deep stabilization, ISSS, DNS, and regional pressure models; and
- active muscles distinguished from their force-transmitting connective tissues, the osseous-articular core, and AxCFUs.

Statement 11. Nested Functional Organization

Primary Definition

*The **AxO** is organized as a nested system comprising the system-level AxO, overlapping regional subsystems, local articulation-centered AxCFUs, shared airway-related components, active neuromuscular and pressure-regulating effectors, peripheral somatic and autonomic neural components, force-transmitting and sensory connective tissues, the craniospinal meningeal subsystem, and their constituent structures. The state of the AxO cannot be inferred by simple addition of isolated joint or soft-tissue findings.*

Commentary

An AxCFU retains PP1's articulation-centered definition, encompassing the components needed for joint mechanics, sensorimotor control, and afferent signaling (Živný & Živná, 2026). The mechanisms described above connect these local units with larger regions.

AxCFUs overlap where muscles, fasciae, ligaments, vessels, nerves, or sensory fields serve several articulations. Pelvic, thoracic, UTA, CCJ, craniomandibular, and hyoid–laryngeal

subsystems organize these relationships. The TMJ units share a mandible and coordinated muscle action but remain locally describable; meningeal continuity spans regions without becoming a chain of AxCFUs.

Shared and non-articulating tissues retain the classes assigned in Table 3 even when they act across regions. Connective-tissue continuity does not collapse tissue, unit, regional, and system levels.

Measurements must match the claim. Joint measurements describe selected articular features, not an entire AxCFU. EMG records electrical activity; pressure, strain, shear, and displacement measure other variables. The latter mechanical responses are not direct transmitted-force measurements (Mohr et al., 2023). Regional and system assessments require coupled-region and regulatory measures, not counts of local abnormalities.

Defining Characteristics

- AxO as the system level;
- overlapping regional subsystems beneath the system level;
- AxCFU as the local articulation-centered functional unit;
- active and pressure-regulating effectors, peripheral neural components, connective tissues, and meninges that cross levels without becoming AxCFUs; and
- level- and mechanism-specific measurement rather than simple summation of findings.

Statement 12. AxO Functional State and Relationship to AxB

Primary Definition

*The **functional state of the AxO** is the time-dependent configuration produced by its closed-loop sensorimotor architecture: central motor and autonomic output acting through the AxO's peripheral somatic and autonomic neural components, skeletal-muscle activity, joint and craniomandibular relationships, respiratory and abdominopelvic pressure conditions, connective-tissue and meningeal deformation, modality-specific afferent signaling, and sensorimotor regulation across the system. AxB is a local articulation-centered disorder of an AxCFU; AxBb and AxBb Chains represent multiple or functionally interconnected AxBs within the AxO. An altered AxO state may modify afferent signaling but does not by itself establish Persistent Afferent Bias (PAB) or downstream effects within the Somato-Psychic Pathway (SPP).*

Commentary

AxO state is specified by developmental, postural, loading, and regulatory conditions. Normal activity and adaptation change it as well as disruption. Statement 13 distinguishes side-to-side asymmetry from clinically inferred abnormal tonic/isometric balance between opposing muscle groups.

AxB remains articulation-centered, AxBb denotes multiple blocks, and an AxBb Chain denotes their biomechanical and neurophysiological interdependence (Živný & Živná, 2026). These terms do not cover every soft-tissue or hyoid disturbance, and AxO state is not a diagnosis.

Temporomandibular disorders (TMDs; singular TMD) comprise different joint and muscle conditions (Schiffman et al., 2014). TMD, bruxism, joint sounds, jaw deviation, and masticatory pain are not interchangeable with AxB, which requires specific local findings and differential assessment. Two normally functioning TMJs are neither AxBb nor, by their shared mandible alone, an AxBb Chain.

A local disturbance may remain accommodated or alter regional loading and afferent signaling. Wider regulatory effects require separate observations. PAB concerns persistent altered afferent conditions and their state-dependent weighting; it is not an obligatory stage of every AxO process. SPP addresses broader autoregulation and neurodevelopment (Živný, 2026a, 2026b; Živný & Živná, 2026).

Assessment of state combines joint and regional kinematics, muscle activity, respiratory and pressure variables, accessible fascial or dural mechanical measures, sensory consequences, and persistence. Each measure addresses only part of the system.

Defining Characteristics

- time-dependent rather than fixed configuration;
- distinction between active neuromuscular generation, connective-tissue response, and physiological variability versus dysfunction;
- preservation of AxB, AxBb, and AxBb Chain definitions;
- separation of altered peripheral afferent input from PAB; and
- measurements linking local, regional, and system-level states.

Statement 13. Developmentally Appropriate Static and Dynamic Examination of the Entire AxO

Primary Definition

*The **developmentally appropriate static and dynamic examination of the entire AxO** evaluates the axial system both at rest and during movement. At the principal static and dynamic observations, the entire body is fully unclothed and directly visible as one integrated system; examination through clothing or by isolated regional exposure is incomplete. Static examination is performed in basic postural positions natural to the individual's attained motor repertoire and assesses the relative tonic isometric activity of functionally opposing agonist–antagonist postural muscle groups. Dynamic examination assesses axial organization during spontaneous movement, transitions, gait, running, and other age-appropriate tasks, including orofacial activity within the attained repertoire. In newborns and infants, spontaneous observation is complemented by age-appropriate positional and postural-reaction tests. Every asymmetry and every axial eccentricity is assessed and documented across conditions. Within this framework, axial eccentricity denotes a non-physiological agonist–antagonist ratio of tonic isometric activity between functionally opposing postural muscle groups, most characteristically the ventral and dorsal axial groups, in basic positions; the relevant activity is predominantly, and in some positions virtually exclusively, tonic and isometric rather than phasic. This definition concerns the examined static condition and does not classify the muscles themselves as exclusively tonic or as incapable of phasic activity during movement. Asymmetry denotes any side-to-side difference in posture, muscle recruitment, movement, or load transfer.*

Commentary

The caudocranial survey follows the pelvic ring, spine, rib cage, UTA, hyoid–cervical region, CCJ, and entire skull, including the mandible and TMJs. Record developmental position and task conditions; local passive tests complement rather than replace this survey.

Direct examination of the entire unclothed body. Clothing, footwear, diapers, undergarments, orthoses, and other coverings can obscure contours, skin folds, muscle configuration, support, load transfer, and compensation. Record coverings or devices that cannot be removed safely. If a dynamic task cannot safely be performed fully unclothed, use the closest safe, unobstructed alternative and document the limitation. Obtain explicit consent, assent where applicable, and parental or guardian involvement for vulnerable persons. Provide chaperoning, warmth, privacy, and dignity. If consent is declined or withdrawn, omit or stop the

observation and document the resulting limitation. Exposure may be staged between observations, but the principal observations require a simultaneous view of the entire unclothed body.

Static assessment uses positions the person can assume naturally and safely. Quiet standing includes equilibrium adjustments (Ivanenko & Gurfinkel, 2018); tonic/isometric describes sustained activity, not absence of sway or phasic corrections. Tissue mechanics and hyoid recruitment vary with position and active/passive conditions (Kellis et al., 2024; Mohr et al., 2023; Sageshima et al., 2022). Assess pelvis–trunk–rib cage–neck–head relations, support, load transfer, breathing, and opposing-group activity.

Axial eccentricity concerns tonic isometric agonist–antagonist balance, not geometric off-centering or eccentric contraction. Possible manifestations include persistent ventral or dorsal dominance, disproportionate co-activation, impaired relaxation, and position-dependent configuration. Posture cannot quantify the activity ratio; clinical identification remains inferential. Validation requires surface and/or intramuscular EMG with task- and position-specific normalization and simultaneous kinematics.

Dynamic assessment includes spontaneous movement, developmental transitions, gait, running, turning, reaching, acceleration, and deceleration as the repertoire permits. Speed, load, repetition, perturbation, or fatigue may disclose asymmetries absent at rest. Infant locomotion also occurs in short, variable bouts rather than only straight standardized trials (Adolph et al., 2012).

Trained examiners should supplement newborn and infant spontaneous observation with safe, clinically appropriate postural tests. These may include traction, ventral suspension/Landau, axillary suspension, Vojta side-tilting, Collis horizontal, Peiper–Isbert, and Collis vertical responses. The International Vojta Society (n.d.) documents the set and its developmental interpretation; Vojta (2008) is the classic methodological reference. Interpret responses alongside spontaneous behavior and a comprehensive neurological examination (Norén & Franzén, 1981; Zafeiriou, 2004; Zafeiriou et al., 1998). They are not validated AxO criteria.

Infant assessment follows the emerging repertoire: supine, prone, and side-lying behavior; rolling; sitting with or without support; quadruped and kneeling; pull-to-stand; standing; and gait. Developmental kinesiology and observational milestone studies support stage-specific interpretation (Piper et al., 1992; Vojta & Peters, 2007; WHO Multicentre Growth Reference Study Group, 2006).

Older children and adults are observed in habitual sitting, kneeling, and standing and during relevant transfers and locomotor tasks. With delayed, atypical, or limited repertoires, start in the most natural available position with usual supports. Age expectations guide interpretation without replacing actual capacity.

Cranial and orofacial assessment records head–neck orientation, facial and mandibular symmetry, resting jaw configuration, and movement, including pain, reproducibility, and task dependence. Feeding, mastication, swallowing, and speech-motor activity are observed only when appropriate to repertoire, clinical question, and safety. Describe bilateral joint findings, recruitment, hyoid relations, and head–neck co-movement separately; language or feeding difficulty does not establish a TMJ cause.

Describe cranial shape and development without presuming a PRM or manual cranial-motion pattern. Claims of changed sphenoid position or synchondral mobility require independent measurement. Intraoral procedures, detailed orofacial tests, differential assessment, and interventions belong in separate methodological work.

Asymmetry may affect alignment, recruitment, range, support, load transfer, trajectory, timing, amplitude, or sequence. Axial eccentricity can occur symmetrically or with a right–left difference. Document every finding by region, direction, magnitude, persistence, reproducibility, and response to position, task, speed, load, repetition, perturbation, or fatigue. Infant neurological asymmetry scores may add information beyond a global score, but no validated AxO threshold separates normal variation from pathology (Hay et al., 2018).

Compare static, spontaneous, task-evoked, postural-reaction, and passive findings. Palpation and passive AxCFU testing follow the entire-AxO survey; recheck local findings in the natural active position or the task that disclosed them.

Separate methodological work must establish procedures, developmental sequences, safety, scoring, reliability, and physiological interpretation. These principles are not a complete validated protocol.

Defining Characteristics

- complementary static examination at rest and dynamic examination during movement;
- caudocranial survey through the entire skull, mandible, and paired TMJs while preserving the system context;

- principal observations of the entire body fully unclothed, with unavoidable coverings or devices documented;
- consent, assent where applicable, parental or guardian involvement, appropriate chaperoning, warmth, dignity, privacy, and documentation of unavoidable coverings or devices;
- tonic/isometric opposing-group activity, especially ventral–dorsal, assessed in developmentally natural positions;
- spontaneous movement, transitions, gait, running, and orofacial tasks as development permits;
- neonatal and infant postural reactions interpreted by gestational or corrected age, behavioral state, repertoire, safety, and Vojta-derived developmental phases;
- distinction between axial eccentricity—a non-physiological opposing-group tonic isometric activity ratio—and side-to-side asymmetry;
- every asymmetry and axial eccentricity documented across positions, tasks, support, load, speed, repetition, perturbation, and fatigue;
- comparison across observation modes, with local findings rechecked in active conditions;
- clinical eccentricity treated as an inference requiring EMG and kinematics; neither it nor asymmetry alone establishes AxB, PAB, etiology, or downstream diagnosis; and
- detailed protocols, scoring, training, safety, and validation reserved for separate methodological papers.

Relationship of AxO to Related Constructs

Table 5 compares AxO with constructs addressing bone groups, local biomechanics, muscular control, and connective-tissue relationships. Their overlap must be distinguished from equivalent boundaries or measurement targets.

Table 5. Relationship of AxO to related constructs

Related construct	Principal overlap	Distinction from AxO
Axial skeleton	Osseous framework of the body axis	Osseous grouping rather than the complete articular, muscular, connective-tissue, meningeal, vascular, and neural system.
Vertebral column / spine	Central longitudinal axial structure	One component, excluding pelvic, costal, cranial, craniomandibular, hyoid, and shared-tissue organization.
Axial system / axial apparatus	Systems-level description of axial structures	Earlier accounts differ in scope. PP2 specifies boundaries, roles, regions, and AxCFU/AxB relationships; muscles and neural feedback are established antecedents.
Spinal motion segment / functional spinal unit	Local articulation-centered biomechanics	Restricted to vertebral levels and usually narrower than the complete AxCFU.
Panjabi's spinal stabilizing system	Integrated passive, active, and neural control (Panjabi, 1992).	A functional-control antecedent, not a synonym of AxO; central-regulator and component boundaries differ.
Craniomandibular / orofacial motor systems	Jaw mechanics and coordination with hyoid, tongue, face, and head–neck activity.	TMJs center local AxCFUs; broader orofacial function is neither one joint nor the whole AxO. TMD is not AxB.
Kinetic chain / regional interdependence	Regional mechanical relationships and the broader clinical model of interdependence (Sueki et al., 2013).	Interdependence may span several systems, beyond force transfer. AxO specifies anatomical inclusion and boundaries.
Fascial-chain / myofascial-continuity models	Connective-tissue force transmission and sensory relationships	Regional transmission, elastic-energy storage, and sensory input participate in control. Slow myofibroblast tension is not phasic muscle activity or proof of unrestricted whole-body effects.

Related construct	Principal overlap	Distinction from AxO
Deep stabilization concepts; ISSS; DNS	Developmentally informed coordination of selected axial and abdominal muscles, thoracic diaphragm, pelvic floor, and intra-abdominal-pressure regulation	Overlap in active coordination and pressure regulation, not equivalent boundaries, AxCFUs, or whole-AxO organization.
Somatic dysfunction	Multicomponent mechanical, myofascial, vascular, lymphatic, muscular, and neural disturbance	A broader dysfunction construct. AxO distinguishes force generation, tissue response, sensory return, and control.
Cranial osteopathy / craniosacral system / central axis	Skull, mandible, cranio-cervical, dural, and myodural relationships	Anatomy is assessed separately from PRM, proposed cranial-motion patterns, and unrestricted transmission. A fused adult junction is not a mobile symphysis.
Echinoderm axial organ	Name only	Unrelated zoological structure and not part of the human AxO concept.

Abbreviations: DNS, Dynamic Neuromuscular Stabilization; ISSS, integrated spinal stabilizing system; PRM, primary respiratory mechanism; TMD, temporomandibular disorder; TMJ, temporomandibular joint (plural TMJs).

Consistency with Prior SPP Publications

Table 6 records what PP2 retains, specifies, or interprets from PP1, PAB, and SPP (Živný, 2026a, 2026b; Živný & Živná, 2026). Entire-skull and paired-TMJ inclusion specify the endpoint of the unchanged PP1 definition.

SPP's proposed developmental priority remains compatible with reciprocal ongoing regulation. The domain interpretation includes normal function and disruption, while Figure 2 depicts recurrence rather than developmental ordering. Neither constitutes validation of PAB or of downstream regulatory effects (Živný, 2026a, 2026b).

Table 6. Consistency matrix for AxO-related terminology

Construct	Status in Position Paper No. 2	Consistency rule
AxO	PP1 definition retained as the first sentence; cranial extent, component classes, and roles specified.	Pelvic-to-skull scope includes mandible and TMJs, not every enclosed structure.
Closed-loop sensorimotor architecture	Muscle force, pressure, tissue response, afferent return, and central updating with parallel autonomic modulation.	Autonomic modulation is not a second mechanical effector chain. The loop alone is not PAB, Somato-Psychic Autonomic Dysregulation (SPAD), or Somato-Psychic Syndrome (SPS).
Peripheral somatic and autonomic neural components	Included when directly innervating or regulating AxO tissues.	Central regulators remain outside AxO; shared peripheral pathways qualify through AxO-directed supply.
Postural musculature and respiratory–postural components	Postural roles defined functionally; diaphragm, abdominal wall, and pelvic floor are shared effectors.	Neither an anatomical muscle class, core component, nor AxCFU. Deep stabilization, ISSS, and DNS overlap without equivalence.
Entire skull / occipital–sphenoidal region	Entire skull included; occiput–C1–C2 connects it to the vertebral column. Sphenoid roles specified.	No universal vertebral homology, intracranial-organ inclusion, or PRM. Synchondrosis differs from synostosis.
TMJs / cranio-mandibular subsystem	Each TMJ centers an AxCFU; the paired units and shared tissues form a coupled regional subsystem.	TMJ, TMD, and AxB differ. Bilateral joints are not AxBb, and coupling alone is not an AxBb Chain.
Superior thoracic aperture	Cervicothoracic regional subsystem within the included spine and rib cage.	A formalization of existing AxO continuity; it is not one AxCFU or a literal diaphragm.

Construct	Status in Position Paper No. 2	Consistency rule
Fasciae	Regional force transmission, constraint, elastic-energy storage, and sensory roles.	Slow myofibroblast tension differs from phasic actuation. Sympathetic labeling or covariation establishes neither interoception nor a dedicated circuit.
Dura mater	Meningeal subsystem with focal occipital, myodural, ligamentous, and vertebral interfaces.	Neither AxCFU nor phasic effector; no unrestricted transmission or specific rhythm implied.
Hyoid complex	Suspended functional component.	An extension/formalization; not presented as an articulation or AxCFU.
Shared cervical–cervicothoracic airway framework	Major laryngeal cartilages and proximal tracheal cartilage/connective tissue included in direct axial roles.	Shared category, not a change to PP1 core, AxCFU, or AxB definitions. No distal airway or therapeutic effect inferred.
AxCFU	Definition retained	Remains associated with a specific AxO articulation and may overlap neighboring units.
AxB	Definition retained	Remains an articulation-centered functional disorder of an AxCFU and a possible peripheral source of altered afferent input.
AxBb / AxBb Chain	Definitions retained	Multiplicity remains distinct from functional chain-level interdependence.
PAB	Proposed persistence-related mechanism, distinct from AxO and ordinary state changes.	Persistence and state-dependent weighting differ from local deformation, transient input, or connectivity. PAB is not obligatory.
SPP	Regulatory–developmental interpretation retaining the published trajectory.	Interpretation, not replacement definition. Reciprocal regulation and developmental ordering coexist; AxO is one participating somatic domain.

Intended Use and Added Value

Clinical reports can identify the region, component or function, task, developmental conditions, and level of each observation. This makes local findings distinguishable from the broader explanation proposed for them.

Consider a hypothetical local restriction and right–left gait difference. Their coexistence does not establish a chain or autonomic disorder. Test whether both are reproducible, how loading and movement relate across regions, and whether they change together under defined conditions. Regulatory consequences require additional measurements.

Repeated developmental observations should separate anatomy, attained motor repertoire, support conditions, adaptation, and disruption. A change of posture or task can change AxO state without being pathological.

In a second hypothetical example, asymmetric jaw opening and head–neck co-movement are separate observations within a coupled region. Joint restriction, altered recruitment, and other causes require differentiation. An orofacial task outcome, an AxCFU finding, and a regulatory outcome need separate endpoints.

Methodological studies must test reliable observation, regional interactions, and added predictive or decision-making value against sound regional assessment and existing models. Negative findings must allow revision. More detailed description alone does not demonstrate patient benefit.

Limitations and Research Priorities

Regional anatomy and mechanics support the proposal, but AxO has not been validated as an integrated measurable system. Whole-system measurement requires evidence beyond the regional findings.

Shared airway inclusion relies chiefly on adult geometry, material testing, and hyoid responses to muscle and lung-volume changes. Developmental participation, axial force transfer, and reproducible distal boundaries remain unresolved. Figure 1 is illustrative and supplies no independent anatomical evidence.

Historical coverage is selective and includes secondary attributions; it establishes neither priority nor complete original definitions. Occipital homology varies by component. The functional extent and clinical interpretation of the UTA region remain to be operationalized, without assuming a unitary diaphragm or universal bottleneck.

Entire-skull inclusion, TMJ-centered units, and orofacial assessment combine classification choices with regional evidence. Adult jaw–neck recordings do not establish pediatric norms, and cadaveric sphenoid attachments do not quantify living cranial motion or remote forces. PRM and mobility of fused junctions are not diagnostic premises.

The fascial and meningeal evidence is constrained by cadaveric, fetal, animal, and disease-specific sampling and by indirect mechanical measures (Statement 8; Table 4). Innervation and attachment maps do not establish receptor physiology, symptoms, or treatment effects (Fede et al., 2022; Sakamoto et al., 2026; Scali et al., 2015; Tereshenko et al., 2026; Venne et al., 2017).

Myofibroblast effects on normal human prestress, stiffness, contracture, and remodeling remain unquantified. Slow pharmacological responses and rat-derived human force estimates cannot establish centrally commanded fascial motor action (Hoppe et al., 2014; Schleip et al., 2019).

AxO-directed supply is a functional boundary, not a separable neural partition. Regional somatic and sympathetic/catecholaminergic findings do not establish all proposed parasympathetic or vagal roles, a dedicated fascia–autonomic circuit, or treatment effects. Detailed bidirectional AxO–autonomic physiology requires separate investigation.

Diagnostic and EMG thresholds for axial eccentricity, asymmetry, and system-level pathology are unvalidated. Examination conditions—including exposure, temperature, behavior, supports, consent, and chaperoning—may affect reliability and require standardization. PP2 supplies neither a stand-alone diagnosis nor a universal intervention sequence.

Operationalization and reproducibility. Develop static, dynamic, neonatal/infant, and orofacial observation modules with defined support and safety conditions. Separate chronological, gestational, or corrected age from attained repertoire. Test examiner agreement, test–retest reliability, and normalized EMG/kinematic agonist–antagonist measures. Compare static-only, dynamic-only, and combined assessment across speed, load, perturbation, repetition, and fatigue; distinguish TMJ findings from broader oral-motor performance.

Anatomical boundaries and developmental reference data. Map occipitocervical, pelvic–spinal, spinal–costal, UTA, and hyoid relationships and directly participating neural pathways. Include vertebral and articular branches, sinuvertebral nerves, rami communicantes, sympathetic trunks and ganglia, and perivascular plexuses. Establish parasympathetic or vagal roles directly. Study shared airway anatomy, axial function, and intervention effects separately across development.

Task-dependent mechanics. Measure kinematics, pressure, strain, shear, and transmission under defined load, activation, posture, and respiration. Separate the anatomical UTA from the clinical outlet. Compare axial and non-axial roles of diaphragm, abdominal wall, and pelvic floor, and test deep-stabilization, ISSS, and DNS measures against broader AxO measures. Establish developmental and task-specific recruitment reference data.

Tissue-specific mechanisms. Test mechanosensory contributions to proprioception, nociception, and autonomic roles by region, layer, age, and clinical state. Quantify human myofibroblast tension independently of muscle force. Map myodural and meningovertebral attachments and measure deformation with controls for attenuation and decoupling. Study axial afference alongside vestibular, visual, and other inputs.

Regulatory coupling and persistence. Test whether AxO changes precede or predict afferent changes, separating transient alterations, persistent conditions, and PAB. Longitudinal cohorts should combine multimodal autonomic measures, respiratory control, tissue imaging, perfusion or fluid-dynamics measures, and preregistered temporal analyses. Test both directions of tissue–autonomic influence, distinguishing efferent regulation from sensory afference and interoception.

Incremental and clinical value. Compare integrated assessment with regional measures and existing approaches. Specify gains in description, prediction, decisions, or outcomes relative to cost and complexity, using separate local, regional, system, and SPP-related endpoints. Negative results should delimit or revise the framework.

Conclusion

Defining AxO separates the structures included in the system from their shared functions and influences across its boundaries. Local restriction, regional interaction, and system state can then be described and tested without treating one as evidence of the others.

PP1 supplies articulation-centered terminology; PP2 locates it in the somatic domain; PAB addresses persistent afferent bias; SPP provides the broader regulatory–developmental context. A regional explanation needs evidence of interaction, and a regulatory explanation needs measures beyond local mechanics.

The next task is to turn the examination principles into reproducible measures and compare their explanatory and clinical value with existing assessments. The usefulness of the proposed distinctions will depend on what those comparisons show.

Summary of Definitions

Table 7. Summary of definitions introduced or formalized in the AxO framework

Stat.	Defined construct	Summary of definition / formalization
1	Axial Organ (AxO)	*The continuous pelvic-to-skull biomechanical and neurophysiological system defined in PP1. The cranial region includes the entire skull, sphenoid, mandible, and paired TMJs with directly participating tissues. Occiput–C1–C2 is its principal vertebral connection. The hyoid is a suspended component; the cervical–cervicothoracic airway framework is shared by role.*
2	Functional-systems status	*A coordinated structural, mechanical, connective-tissue, meningeal, sensorimotor, vascular, and directly participating peripheral somatic and autonomic neural system of the body axis, not a discrete organ in conventional gross anatomy; brain, spinal cord, and central autonomic network regulate but are not AxO components.*
3	Structural core and extent	*Pelvic ring; vertebral column including sacrum and coccyx; rib cage and articulations; CCJ; entire skull, including the sphenoid and mandible, with its articulations. Sphenoidal muscular and meningeal roles are specified.*
4	Superior thoracic aperture	*An oblique T1–first-rib–manubrial opening and adjacent three-dimensional cervicothoracic transition zone; a regional subsystem comprising multiple AxCFUs and interfaces, not a single AxCFU or literal diaphragm.*
5	Component classes and interfaces	*Core axial components, AxCFUs, regional subsystems and transition complexes, suspended components, shared airway-related components, active neuromuscular and pressure-regulating effectors, peripheral somatic and autonomic neural components, force-transmitting and sensory connective tissues, the craniospinal meningeal subsystem, and boundary interfaces are distinguished by role.*
6	Hyoid complex and shared airway framework	*Suspended hyoid complex linked by muscles, fasciae, ligaments, and sensorimotor relationships to cranial, mandibular, cervical, laryngeal, sternal, and shoulder regions; not itself an AxCFU. Thyroid/cricoid and cervical–cervicothoracic tracheal cartilage and connective tissue are shared by axial role, not automatically AxCFUs and without extending the osseous-articular core or including the whole respiratory system.*
7	Active force generation and closed-loop sensorimotor architecture	*Neurally controlled tonic/isometric and phasic muscle force and respiratory/abdominopelvic pressure interact with connective-tissue transmission, constraint, and elastic-energy storage. Loading of innervated tissues can alter afferent signaling; central integration updates output and AxO state. Coupling is graded, heterogeneous, and history-dependent.*
8	Fascial and meningeal integration	*Fasciae are anatomically distinct, non-phasic, region-specific connective tissues with force-transmitting, constraining, elastic-energy-storing, and region-specific sensory roles; craniospinal dura is an internal meningeal continuum with focal axial attachments. Slow myofibroblast-mediated cellular tension may influence longer-timescale tissue prestress, stiffness, contracture, or remodeling but is not rapid motor actuation. Sympathetic fibers alone do not establish a distinct fascial interoceptive organ.*

Stat.	Defined construct	Summary of definition / formalization
9	Neurophysiological integration	*Directly participating peripheral somatic and autonomic neural components, distributed afferent signaling with sensory modality specified where supported, and segmental/suprasegmental sensorimotor and autonomic control without a single dedicated AxO pathway. Brain, spinal cord, and central autonomic network regulate but are not AxO components; shared peripheral pathways are included only in AxO-directed portions.*
10	Respiratory–postural coupling	*Shared active neuromuscular and pressure-regulating contribution of thoracic diaphragm, abdominal wall, and pelvic floor to ventilation, respiratory and abdominopelvic pressure regulation, and task-dependent axial stabilization. Rib cage and superior thoracic aperture are structural regions; the shared muscles are not core osseous-articular components or independent AxCFUs. Deep stabilization-system constructs and ISSS overlap with this function, and DNS is a related clinical approach; none is an AxO synonym.*
11	Nested organization	*System-level AxO, overlapping regional subsystems, including the craniomandibular apparatus and its paired TMJ-centered AxCFUs, articulation-centered AxCFUs, shared airway-related components, active neuromuscular and pressure-regulating effectors, peripheral somatic and autonomic neural components, connective-tissue transmission substrates, the meningeal subsystem, and constituent structures.*
12	AxO functional state	*The time-dependent configuration generated by central motor and autonomic output acting through peripheral neural components, skeletal-muscle activity, joint, craniomandibular, and respiratory/abdominopelvic pressure conditions, connective-tissue and meningeal deformation, afferent signaling, and updated sensorimotor regulation; distinct from AxB, PAB, and downstream SPP effects.*
13	Developmentally appropriate static and dynamic examination of the entire AxO	*Static and dynamic assessment requires principal observations of the entire unclothed body, with consent/assent, privacy, chaperoning, warmth, dignity, safety, and recorded unavoidable limitations. Positions follow attained development; movement includes transitions, gait, running, and appropriate orofacial tasks. Infants also undergo age-appropriate postural reactions. Axial eccentricity concerns a non-physiological tonic/isometric agonist–antagonist activity ratio, especially ventral–dorsal, not an exclusively tonic muscle class. Asymmetry is side-to-side difference. Every asymmetry and eccentricity is assessed and documented.*

Abbreviations

Table 8. Abbreviations used in the manuscript

Abbreviation	Full term / meaning
AI	Artificial intelligence
α-SMA	α-Smooth muscle actin
AxB	Axial Block (grammatical plural AxBs)
AxBb	Multiple Axial Blocks (collective designation)
AxCFU	Axial Corresponding Functional Unit (plural AxCFUs)
AxO	Axial Organ
CCJ	Cervico-cranial junction
CGRP	Calcitonin gene-related peptide
CRediT	Contributor Roles Taxonomy
CTJ	Cervicothoracic junction
DNS	Dynamic Neuromuscular Stabilization
EMG	Electromyography
HRV	Heart rate variability
ISSS	Integrated spinal stabilizing system
OCI	Obliquus capitis inferior
PAB	Persistent Afferent Bias
PGP9.5	Protein gene product 9.5
PP1	SPP Institute Position Paper No. 1
PP2	SPP Institute Position Paper No. 2 (the present paper)
PRM	Primary respiratory mechanism (cranial-osteopathic construct; not adopted in PP2)
RCP major	Rectus capitis posterior major
RCP minor	Rectus capitis posterior minor
SIJ	Sacroiliac joint (plural SIJs)
SPAD	Somato-Psychic Autonomic Dysregulation
SPP	Somato-Psychic Pathway
SPS	Somato-Psychic Syndrome
TH	Tyrosine hydroxylase
TMD	Temporomandibular disorder (plural TMDs)
TMJ	Temporomandibular joint (plural TMJs)
UTA	Upper thoracic aperture; shorthand for the superior thoracic aperture in this paper
WHO	World Health Organization

AxBs is the grammatical plural of AxB; AxBb denotes multiple Axial Blocks as a collective. AxBb Chain retains the interconnected-chain meaning defined in PP1. C and T denote cervical and thoracic vertebral levels; Ca^{2+} denotes calcium ions. S100 and Piezo2 are molecular marker names, not initialisms.

CRediT Author Statement

Boris Živný: Conceptualization, Methodology, Project administration, Investigation, Writing – original draft, Writing – review & editing.

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Conflict of Interest

The authors developed the AxO/AxB framework and are affiliated with SPP Institute and NeuroCentrum Clinic, where related clinical and research work is conducted. They disclose this institutional and intellectual involvement and declare no other potentially conflicting commercial or financial relationships.

Data Availability Statement

No new datasets were generated or analyzed. Published sources are cited in the manuscript. Further inquiries may be directed to the corresponding author.

Ethics Statement

No new human or animal research was conducted for this paper. Clinical observations are discussed conceptually and in aggregate, without participant-level or identifiable personal data.

Generative AI Statement

Generative artificial intelligence (AI) assisted language editing, organization, and literature searches. The authors remain responsible for the manuscript and for critical review and final approval of its concepts, definitions, interpretations, sources, and conclusions. ChatGPT image generation (OpenAI) produced the anatomical base for Figure 1 and the initial layout for Figure 2. Figure 1 received targeted color corrections and airway overlays using image-processing and vector tools. Figure 2 was rebuilt with controlled vector geometry and editable text. Figures 1 and 2 are conceptual illustrations rather than patient images, measured gait records, or validated anatomical or quantitative models. The captions identify each figure’s provenance and limits.

References

Adolph, K. E., Cole, W. G., Komati, M., Garciaguirre, J. S., Badaly, D., Lingeman, J. M., Chan, G. L. Y., & Sotsky, R. B. (2012). How do you learn to walk? Thousands of steps and dozens of falls per day. *Psychological Science*, *23*(11), 1387–1394. https://doi.org/10.1177/0956797612446346

Barker, P. J., Briggs, C. A., & Bogeski, G. (2004). Tensile transmission across the lumbar fasciae in unembalmed cadavers: Effects of tension to various muscular attachments. *Spine*, *29*(2), 129–138. https://doi.org/10.1097/01.BRS.0000107005.62513.32

Bolaños, P., & Calderón, J. C. (2022). Excitation–contraction coupling in mammalian skeletal muscle: Blending old and last-decade research. *Frontiers in Physiology, 13*, 989796. https://doi.org/10.3389/fphys.2022.989796

Brandl, A., Engel, R., Egner, C., Schleip, R., & Schubert, C. (2024). Relations between daily stressful events, exertion, heart rate variability, and thoracolumbar fascia deformability: A case report. *Journal of Medical Case Reports*, *18*, 589. https://doi.org/10.1186/s13256-024-04935-z

Cavelier, S., Quarrington, R. D., & Jones, C. F. (2023). Tensile properties of human spinal dura mater and pericranium. *Journal of Materials Science: Materials in Medicine*, *34*(1), 4. https://doi.org/10.1007/s10856-022-06704-0

Civelek, E., Karasu, A., Cansever, T., Hepgul, K., Kiris, T., Sabanci, A., & Canbolat, A. (2008). Surgical anatomy of the cervical sympathetic trunk during anterolateral approach to cervical spine. *European Spine Journal*, *17*(8), 991–995. https://doi.org/10.1007/s00586-008-0696-8

Connolly, M. R., & Auchincloss, H. G. (2021). Anatomy and embryology of the thoracic outlet. *Thoracic Surgery Clinics*, *31*(1), 1–10. https://doi.org/10.1016/j.thorsurg.2020.09.007

Čuj, J., Gajdoš, M., Mikuľáková, W., Jurčišin, M., & Kračmar, B. (2019). Je stacionárny bicykel vhodným doplnkom fyzioterapeutickej liečby pri vertebrogénnych ťažkostiach? [Is the stationary bicycle a suitable supplement of physiotherapy in vertebrogenic difficulties]. *Rehabilitace a fyzikální lékařství*, *26*(4), 198–204. https://www.prolekare.cz/casopisy/rehabilitation-physical-medicine/2019-4-25/je-stacionarny-bicykel-vhodnym-doplnkom-fyzioterapeutickej-liecby-pri-vertebrogennych-tazkostiach-122205

Danto, J. B. (2003). Review of integrated neuromusculoskeletal release and the novel application of a segmental anterior/posterior approach in the thoracic, lumbar, and sacral regions. *Journal of the American Osteopathic Association, 103*(12), 583–596. https://pubmed.ncbi.nlm.nih.gov/14740981/

David, K. M., McLachlan, J. C., Aiton, J. F., Whiten, S. C., Smart, S. D., Thorogood, P. V., & Crockard, H. A. (1998). Cartilaginous development of the human craniovertebral junction as visualised by a new three-dimensional computer reconstruction technique. *Journal of Anatomy, 192*(2), 269–277. https://doi.org/10.1046/j.1469-7580.1998.19220269.x

Diaconescu, N. (1987). Intersomatic morphogenetic (osteo-fibro-musculo-articular) correlations at the level of the body axial organ. *Morphologie et Embryologie*, *33*(2), 87–93. https://pubmed.ncbi.nlm.nih.gov/2956512/

Eriksson, P.-O., Häggman-Henrikson, B., Nordh, E., & Zafar, H. (2000). Co-ordinated mandibular and head-neck movements during rhythmic jaw activities in man. *Journal of Dental Research, 79*(6), 1378–1384. https://doi.org/10.1177/00220345000790060501

Eriksson, P.-O., Zafar, H., & Nordh, E. (1998). Concomitant mandibular and head-neck movements during jaw opening–closing in man. *Journal of Oral Rehabilitation, 25*(11), 859–870. https://doi.org/10.1046/j.1365-2842.1998.00333.x

Fede, C., Petrelli, L., Guidolin, D., Porzionato, A., Pirri, C., Fan, C., De Caro, R., & Stecco, C. (2021). Evidence of a new hidden neural network into deep fasciae. *Scientific Reports*, *11*(1), 12623. https://doi.org/10.1038/s41598-021-92194-z

Fede, C., Petrelli, L., Pirri, C., Neuhuber, W., Tiengo, C., Biz, C., De Caro, R., Schleip, R., & Stecco, C. (2022). Innervation of human superficial fascia. *Frontiers in Neuroanatomy, 16*, 981426. https://doi.org/10.3389/fnana.2022.981426

Feipel, V., Vanden Berghe, M., & Rooze, M. A. (2003). No effects of cervical spine motion on cranial dura mater strain. *Clinical Biomechanics, 18*(5), 389–392. https://doi.org/10.1016/S0268-0033(03)00041-X

Frank, C., Kobesova, A., & Kolar, P. (2013). Dynamic neuromuscular stabilization & sports rehabilitation. *International Journal of Sports Physical Therapy, 8*(1), 62–73. https://pubmed.ncbi.nlm.nih.gov/23439921/

Gaughran, G. R. L. (1964). Suprapleural membrane and suprapleural bands. *The Anatomical Record*, *148*(4), 553–559. https://doi.org/10.1002/ar.1091480406

Geers, C., Lecouvet, F. E., Behets, C., Malghem, J., Cosnard, G., & Lengelé, B. G. (2003). Polygonal deformation of the dural sac in lumbar epidural lipomatosis: Anatomic explanation by the presence of meningovertebral ligaments. *AJNR American Journal of Neuroradiology*, *24*(7), 1276–1282. https://pubmed.ncbi.nlm.nih.gov/12917112/

Golconda, P., Buckley, K. M., Reynolds, C. R., Romanello, J. P., & Smith, L. C. (2019). The axial organ and the pharynx are sites of hematopoiesis in the sea urchin. *Frontiers in Immunology, 10*, 870. https://doi.org/10.3389/fimmu.2019.00870

Groen, G. J., Baljet, B., & Drukker, J. (1988). The innervation of the spinal dura mater: Anatomy and clinical implications. *Acta Neurochirurgica*, *92*(1–4), 39–46. https://doi.org/10.1007/BF01401971

Groen, G. J., Baljet, B., & Drukker, J. (1990). Nerves and nerve plexuses of the human vertebral column. *American Journal of Anatomy, 188*(3), 282–296. https://doi.org/10.1002/aja.1001880307

Hack, G. D., Koritzer, R. T., Robinson, W. L., Hallgren, R. C., & Greenman, P. E. (1995). Anatomic relation between the rectus capitis posterior minor muscle and the dura mater. *Spine*, *20*(23), 2484–2486. https://doi.org/10.1097/00007632-199512000-00003

Hack, L. A., & Porges, S. W. (2026). Fascia insights: Dr. Stephen W. Porges on fascia and the autonomic nervous system as an integrated system. *Structure, Function, Integration*, *54*(1). https://www.sfijournal.org/article/fascia-insights-dr-stephen-w-porges-on-fascia-and-the-autonomic-nervous-system-as-an-integrated-system

Hay, K., Nelin, M., Carey, H., Chorna, O., Moore-Clingenpeel, M., & Maitre, N. L. (2018). Hammersmith Infant Neurological Examination asymmetry score distinguishes hemiplegic cerebral palsy from typical development. *Pediatric Neurology, 87*, 70–74. https://doi.org/10.1016/j.pediatrneurol.2018.07.002

Hellmann, D., Giannakopoulos, N. N., Schmitter, M., Lenz, J., & Schindler, H. J. (2012). Anterior and posterior neck muscle activation during a variety of biting tasks. *European Journal of Oral Sciences, 120*(4), 326–334. https://doi.org/10.1111/j.1600-0722.2012.00969.x

Hodges, P. W., Butler, J. E., McKenzie, D. K., & Gandevia, S. C. (1997). Contraction of the human diaphragm during rapid postural adjustments. *The Journal of Physiology, 505*(2), 539–548. https://doi.org/10.1111/j.1469-7793.1997.539bb.x

Hodges, P. W., & Gandevia, S. C. (2000a). Activation of the human diaphragm during a repetitive postural task. *The Journal of Physiology, 522*(1), 165–175. https://doi.org/10.1111/j.1469-7793.2000.t01-1-00165.xm

Hodges, P. W., & Gandevia, S. C. (2000b). Changes in intra-abdominal pressure during postural and respiratory activation of the human diaphragm. *Journal of Applied Physiology, 89*(3), 967–976. https://doi.org/10.1152/jappl.2000.89.3.967

Hodges, P. W., Heijnen, I., & Gandevia, S. C. (2001). Postural activity of the diaphragm is reduced in humans when respiratory demand increases. *The Journal of Physiology, 537*(3), 999–1008. https://doi.org/10.1111/j.1469-7793.2001.00999.x

Hodges, P. W., Sapsford, R., & Pengel, L. H. M. (2007). Postural and respiratory functions of the pelvic floor muscles. *Neurourology and Urodynamics*, *26*(3), 362–371. https://doi.org/10.1002/nau.20232

Hoppe, K., Schleip, R., Lehmann-Horn, F., Jäger, H., & Klingler, W. (2014). Contractile elements in muscular fascial tissue—Implications for in-vitro contracture testing for malignant hyperthermia. *Anaesthesia, 69*(9), 1002–1008. https://doi.org/10.1111/anae.12752

Humphreys, B. K., Kenin, S., Hubbard, B. B., & Cramer, G. D. (2003). Investigation of connective tissue attachments to the cervical spinal dura mater. *Clinical Anatomy, 16*(2), 152–159. https://doi.org/10.1002/ca.10109

International Vojta Society. (n.d.). *Postural responses*. Retrieved September 9, 2026, from https://www.vojta.com/en/the-vojta-principle/vojta-diagnostic/postural-responses

Ivanenko, Y., & Gurfinkel, V. S. (2018). Human postural control. *Frontiers in Neuroscience*, *12*, 171. https://doi.org/10.3389/fnins.2018.00171

Kallakuri, S., Cavanaugh, J. M., & Blagoev, D. C. (1998). An immunohistochemical study of innervation of lumbar spinal dura and longitudinal ligaments. *Spine*, *23*(4), 403–411. https://doi.org/10.1097/00007632-199802150-00001

Kandil, E., Abdelghani, S., Friedlander, P., Alrasheedi, S., Tufano, R. P., Bellows, C. F., & Slakey, D. (2011). Motor and sensory branching of the recurrent laryngeal nerve in thyroid surgery. *Surgery*, *150*(6), 1222–1227. https://doi.org/10.1016/j.surg.2011.09.002

Kellis, E., Kekelekis, A., & Drakonaki, E. E. (2024). Is thoracolumbar fascia shear-wave modulus affected by active and passive knee flexion? *Journal of Anatomy*, *244*(3), 438–447. https://doi.org/10.1111/joa.13977

Kimball, D., Kimball, H., Matusz, P., Tubbs, R. S., Loukas, M., & Cohen-Gadol, A. A. (2015). Ossification of the posterior petroclinoid dural fold: A cadaveric study with neurosurgical significance. *Journal of Neurological Surgery Part B: Skull Base*, *76*(4), 272–277. https://doi.org/10.1055/s-0034-1396598

Kiray, A., Arman, C., Naderi, S., Güvencer, M., & Korman, E. (2005). Surgical anatomy of the cervical sympathetic trunk. *Clinical Anatomy*, *18*(3), 179–185. https://doi.org/10.1002/ca.20055

Kobesova, A., Davidek, P., Morris, C. E., Andel, R., Maxwell, M., Oplatkova, L., Safarova, M., Kumagai, K., & Kolar, P. (2020). Functional postural-stabilization tests according to Dynamic Neuromuscular Stabilization approach: Proposal of novel examination protocol. *Journal of Bodywork and Movement Therapies*, *24*(3), 84–95. https://doi.org/10.1016/j.jbmt.2020.01.009

Kohno, A., Kitamura, Y., Kato, S., Imai, H., Masuda, Y., Sato, Y., & Isono, S. (2019). Displacement of the hyoid bone by muscle paralysis and lung volume increase: The effects of obesity and obstructive sleep apnea. *Sleep*, *42*(1), Article zsy198. https://doi.org/10.1093/sleep/zsy198

Kolář, P., & Lewit, K. (2005). Význam hlubokého stabilizačního systému v rámci vertebrogenních obtíží. *Neurologie pro praxi*, *6*(5), 270–275. https://www.solen.cz/artkey/neu-200505-0010_Vyznam_hlubokeho_stabilizacniho_systemu_v_ramci_vertebrogennich_obtizi.php

Krause, F., Wilke, J., Vogt, L., & Banzer, W. (2016). Intermuscular force transmission along myofascial chains: A systematic review. *Journal of Anatomy, 228*(6), 910–918. https://doi.org/10.1111/joa.12464

Kubíková, H. (2012). *Termín „Hluboký stabilizační systém“ v odborné literatuře za posledních 10 let* [Bachelor’s thesis, Charles University]. Charles University Digital Repository. https://hdl.handle.net/20.500.11956/45684

Liebsch, C., Graf, N., Appelt, K., & Wilke, H.-J. (2017). The rib cage stabilizes the human thoracic spine: An in vitro study using stepwise reduction of rib cage structures. *PLOS ONE*, *12*(6), e0178733. https://doi.org/10.1371/journal.pone.0178733

Liebsch, C., & Wilke, H.-J. (2022). How does the rib cage affect the biomechanical properties of the thoracic spine? A systematic literature review. *Frontiers in Bioengineering and Biotechnology, 10*, 904539. https://doi.org/10.3389/fbioe.2022.904539

Lopez, A. J., Scheer, J. K., Leibl, K. E., Smith, Z. A., Dlouhy, B. J., & Dahdaleh, N. S. (2015). Anatomy and biomechanics of the craniovertebral junction. *Neurosurgical Focus*, *38*(4), E2. https://doi.org/10.3171/2015.1.FOCUS14807

Lottering, N., MacGregor, D. M., Alston, C. L., & Gregory, L. S. (2015). Ontogeny of the spheno-occipital synchondrosis in a modern Queensland, Australian population using computed tomography. *American Journal of Physical Anthropology, 157*(1), 42–57. https://doi.org/10.1002/ajpa.22687

Loukas, M., Zhan, X. L., Tubbs, R. S., Mirchandani, D., & Shoja, M. M. (2008). The ansa subclavia: A review of the literature. *Folia Morphologica*, *67*(3), 166–170. https://pubmed.ncbi.nlm.nih.gov/18828096/

Mense, S. (2019). Innervation of the thoracolumbar fascia. *European Journal of Translational Myology*, *29*(3), 151–158. https://doi.org/10.4081/ejtm.2019.8297

Miyake, N., Takeuchi, H., Cho, B. H., Murakami, G., Fujimiya, M., & Kitano, H. (2011). Fetal anatomy of the lower cervical and upper thoracic fasciae with special reference to the prevertebral fascial structures including the suprapleural membrane. *Clinical Anatomy, 24*(5), 607–618. https://doi.org/10.1002/ca.21125

Mohr, L., Vogt, L., Thiel, C., Behringer, M., & Wilke, J. (2023). Myofascial force transmission between the calf and the dorsal thigh is dependent on knee angle: An ultrasound study. *Scientific Reports, 13*(1), 3738. https://doi.org/10.1038/s41598-023-30407-3

Mortensen, J. D., Vasavada, A. N., & Merryweather, A. S. (2018). The inclusion of hyoid muscles improve moment generating capacity and dynamic simulations in musculoskeletal models of the head and neck. *PLOS ONE, 13*(6), e0199912. https://doi.org/10.1371/journal.pone.0199912

Müller, D. (1968). Entwicklung, Wachstum, Reifung. In *Neurologische Untersuchung und Diagnostik im Kindesalter* (pp. 1–32). Springer. https://doi.org/10.1007/978-3-7091-8200-0_1

Müller, F., & O'Rahilly, R. (1994). Occipitocervical segmentation in staged human embryos. *Journal of Anatomy, 185*(Pt 2), 251–258. https://pubmed.ncbi.nlm.nih.gov/7961131/

Müller, F., & O'Rahilly, R. (2003). Segmentation in staged human embryos: The occipitocervical region revisited. *Journal of Anatomy, 203*(3), 297–315. https://doi.org/10.1046/j.1469-7580.2003.00219.x

Müller-Stephann, H. (1965). Zur Therapie funktioneller Störungen am Achsenorgan: Grundlagen der Achsengymnastik. *Beiträge zur Orthopädie und Traumatologie, 12*(8), 499–511. https://pubmed.ncbi.nlm.nih.gov/5839697/

Nelson, K. E., Sergueef, N., Lipinski, C. M., Chapman, A. R., & Glonek, T. (2001). Cranial rhythmic impulse related to the Traube-Hering-Mayer oscillation: Comparing laser-Doppler flowmetry and palpation. *The Journal of the American Osteopathic Association, 101*(3), 163–173. https://doi.org/10.7556/jaoa.2001.101.3.163

Norén, L., & Franzén, G. (1981). An evaluation of seven postural reactions ("Lagereflexe" selected by Vojta) in twenty-five healthy infants. *Neuropediatrics, 12*(4), 308–313. https://doi.org/10.1055/s-2008-1059662

Obuchowski, A. M., & Ortiz, A. O. (2000). MR imaging of the thoracic inlet. *Magnetic Resonance Imaging Clinics of North America*, *8*(1), 183–203, ix–x. https://pubmed.ncbi.nlm.nih.gov/10730242/

Pang, D., & Thompson, D. N. P. (2011). Embryology and bony malformations of the craniovertebral junction. *Child's Nervous System*, *27*(4), 523–564. https://doi.org/10.1007/s00381-010-1358-9

Panjabi, M. M. (1992). The stabilizing system of the spine. Part I. Function, dysfunction, adaptation, and enhancement. *Journal of Spinal Disorders, 5*(4), 383–389. https://doi.org/10.1097/00002517-199212000-00001

Peter, E. (1970). Die Insuffizienz des Achsenorganes. *Zeitschrift für Rheumaforschung*, *29*(7), 227–233. https://pubmed.ncbi.nlm.nih.gov/5522583/

Pettorossi, V. E., & Schieppati, M. (2014). Neck proprioception shapes body orientation and perception of motion. *Frontiers in Human Neuroscience*, *8*, 895. https://doi.org/10.3389/fnhum.2014.00895

Phillips, S., Mercer, S., & Bogduk, N. (2008). Anatomy and biomechanics of quadratus lumborum. *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, *222*(2), 151–159. https://doi.org/10.1243/09544119JEIM266

Piper, M. C., Pinnell, L. E., Darrah, J., Maguire, T., & Byrne, P. J. (1992). Construction and validation of the Alberta Infant Motor Scale (AIMS). *Canadian Journal of Public Health*, *83*(Suppl. 2), S46–S50. https://pubmed.ncbi.nlm.nih.gov/1468050/

Pirri, C., Petrelli, L., Guidolin, D., Porzionato, A., Fede, C., Macchi, V., De Caro, R., & Stecco, C. (2024). Myofascial junction: Emerging insights into the connection between deep/muscular fascia and muscle. *Clinical Anatomy, 37*(5), 534–545. https://doi.org/10.1002/ca.24148

Pontell, M. E., Scali, F., Marshall, E., & Enix, D. (2013). The obliquus capitis inferior myodural bridge. *Clinical Anatomy, 26*(4), 450–454. https://doi.org/10.1002/ca.22134

Potekhina, Y. P., Tregubova, E. S., & Mokhov, D. E. (2020). The phenomenon of somatic dysfunction and the mechanisms of osteopathic treatment. *Medical News of North Caucasus*, *15*(1), 145–152. https://doi.org/10.14300/mnnc.2020.15036

Riemann, B. L., & Lephart, S. M. (2002). The sensorimotor system, Part II: The role of proprioception in motor control and functional joint stability. *Journal of Athletic Training*, *37*(1), 80–84. https://pubmed.ncbi.nlm.nih.gov/16558671/

Rocabado, M. (1983). Biomechanical relationship of the cranial, cervical, and hyoid regions. *Journal of Craniomandibular Practice*, *1*(3), 61–66. https://doi.org/10.1080/07345410.1983.11677834

Roth, M. (1989). “Obalová” versus biomechanická funkce páteře. *Československá radiologie*, *43*(1), 1–13. https://pubmed.ncbi.nlm.nih.gov/2713950/

Rusu, M. C., Munteanu, I. M., Vrapciu, A. D., Jianu, A. M., Hostiuc, S., Tudose, R. C., & Motoc, A. G. M. (2025). Anatomy, imaging, and clinical significance of the cervicothoracic (stellate) ganglion. *Diagnostics*, *15*(22), Article 2911. https://doi.org/10.3390/diagnostics15222911

Rutter, G., Phan, K., Smith, A., Stewart, F., Seex, K., & Gragnaniello, C. (2017). Morphometric anatomy of the lumbar sympathetic trunk with respect to the anterolateral approach to lumbar interbody fusion: A cadaver study. *Journal of Spine Surgery, 3*(3), 419–425. https://doi.org/10.21037/jss.2017.09.06

Safshekan, F., Tafazzoli-Shadpour, M., Abdouss, M., & Shadmehr, M. B. (2016). Mechanical characterization and constitutive modeling of human trachea: Age and gender dependency. *Materials, 9*(6), Article 456. https://doi.org/10.3390/ma9060456

Sageshima, H., Pavlů, D., Dvořáčková, D., & Pánek, D. (2022). Onset timing of hyoid muscles activation during cervical flexion is position-dependent: An EMG study. *Life*, *12*(7), 949. https://doi.org/10.3390/life12070949

Sağlam, A. M. Ş., & Uydas, N. E. (2006). Relationship between head posture and hyoid position in adult females and males. *Journal of Cranio-Maxillofacial Surgery*, *34*(2), 85–92. https://doi.org/10.1016/j.jcms.2005.07.012

Sakamoto, K., Edama, M., Taguchi, T., Ota, H., Kubo, A., & Sato, N. (2026). Unmyelinated nerve fibers distributed in the human crural fascia of Thiel-embalmed cadavers. *Scientific Reports*. Advance online publication. https://doi.org/10.1038/s41598-026-57388-3

Samuel, E. P. (1952). The autonomic and somatic innervation of the articular capsule. *The Anatomical Record*, *113*(1), 53–70. https://doi.org/10.1002/ar.1091130104

Satoh, J.-I. (1970). The serratus posterior inferior in monkey and man, in particular the structure of the digitations of this muscle and their nerve supply. *Okajimas Folia Anatomica Japonica*, *47*(1), 19–61. https://doi.org/10.2535/ofaj1936.47.1_19

Scali, F., Marsili, E. S., & Pontell, M. E. (2011). Anatomical connection between the rectus capitis posterior major and the dura mater. *Spine*, *36*(25), E1612–E1614. https://doi.org/10.1097/BRS.0b013e31821129df

Scali, F., Pontell, M. E., Nash, L. G., & Enix, D. E. (2015). Investigation of meningomyovertebral structures within the upper cervical epidural space: A sheet plastination study with clinical implications. *The Spine Journal*, *15*(11), 2417–2424. https://doi.org/10.1016/j.spinee.2015.07.438

Schiffman, E., Ohrbach, R., Truelove, E., Look, J., Anderson, G., Goulet, J.-P., List, T., Svensson, P., Gonzalez, Y., Lobbezoo, F., Michelotti, A., Brooks, S. L., Ceusters, W., Drangsholt, M., Ettlin, D., Gaul, C., Goldberg, L. J., Haythornthwaite, J. A., Hollender, L., … Dworkin, S. F. (2014). Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for clinical and research applications: Recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. *Journal of Oral & Facial Pain and Headache*, *28*(1), 6–27. https://doi.org/10.11607/jop.1151

Schilder, A., Hoheisel, U., Magerl, W., Benrath, J., Klein, T., & Treede, R.-D. (2014). Sensory findings after stimulation of the thoracolumbar fascia with hypertonic saline suggest its contribution to low back pain. *Pain*, *155*(2), 222–231. https://doi.org/10.1016/j.pain.2013.09.025

Schilder, A., Magerl, W., Klein, T., & Treede, R.-D. (2018). Assessment of pain quality reveals distinct differences between nociceptive innervation of low back fascia and muscle in humans. *Pain Reports*, *3*(3), e662. https://doi.org/10.1097/PR9.0000000000000662

Schleip, R., Gabbiani, G., Wilke, J., Naylor, I., Hinz, B., Zorn, A., Jäger, H., Breul, R., Schreiner, S., & Klingler, W. (2019). Fascia is able to actively contract and may thereby influence musculoskeletal dynamics: A histochemical and mechanographic investigation. *Frontiers in Physiology*, *10*, 336. https://doi.org/10.3389/fphys.2019.00336

Shapiro, R., & Robinson, F. (1976). Embryogenesis of the human occipital bone. *American Journal of Roentgenology, 126*(5), 1063–1068. https://doi.org/10.2214/ajr.126.5.1063

Sommerfeld, P., Kaider, A., & Klein, P. (2004). Inter- and intraexaminer reliability in palpation of the “primary respiratory mechanism” within the “cranial concept”. *Manual Therapy, 9*(1), 22–29. https://doi.org/10.1016/S1356-689X(03)00099-7

Sousa, A. S. P., Silva, A., & Tavares, J. M. R. S. (2012). Biomechanical and neurophysiological mechanisms related to postural control and efficiency of movement: A review. *Somatosensory & Motor Research*, *29*(4), 131–143. https://doi.org/10.3109/08990220.2012.725680

Sritara, S., Tsutsumi, M., Fukino, K., Matsumoto, Y., Ono, T., & Akita, K. (2021). Evaluating the morphological features of the lateral pterygoid insertion into the medial surface of the condylar process. *Clinical and Experimental Dental Research, 7*(2), 219–225. https://doi.org/10.1002/cre2.353

Stecco, C., Gagey, O., Belloni, A., Pozzuoli, A., Porzionato, A., Macchi, V., Aldegheri, R., De Caro, R., & Delmas, V. (2007). Anatomy of the deep fascia of the upper limb. Second part: Study of innervation. *Morphologie*, *91*(292), 38–43. https://doi.org/10.1016/j.morpho.2007.05.002

Steinmetz, M. P., Mroz, T. E., & Benzel, E. C. (2010). Craniovertebral junction: Biomechanical considerations. *Neurosurgery, 66*(3 Suppl), 7–12. https://doi.org/10.1227/01.NEU.0000366109.85796.42

Suarez-Rodriguez, V., Fede, C., Pirri, C., Petrelli, L., Loro-Ferrer, J. F., Rodriguez-Ruiz, D., De Caro, R., & Stecco, C. (2022). Fascial innervation: A systematic review of the literature. *International Journal of Molecular Sciences*, *23*(10), 5674. https://doi.org/10.3390/ijms23105674

Sueki, D. G., Cleland, J. A., & Wainner, R. S. (2013). A regional interdependence model of musculoskeletal dysfunction: Research, mechanisms, and clinical implications. *Journal of Manual & Manipulative Therapy, 21*(2), 90–102. https://doi.org/10.1179/2042618612Y.0000000027

Sun, Z., Lee, E., & Herring, S. W. (2004). Cranial sutures and bones: Growth and fusion in relation to masticatory strain. *The Anatomical Record Part A: Discoveries in Molecular, Cellular, and Evolutionary Biology, 276A*(2), 150–161. https://doi.org/10.1002/ar.a.20002

Tereshenko, V., Hazewinkel, M. H. J., Hussey, M. R., Remy, K., Hwang, C. D., Mönnink, G. L. E., McCormack, M. C., Gfrerer, L., & Austen, W. G., Jr. (2026). Trapezius fascia reveals mechanosensory capacity and predominance of nociceptive axons in occipital neuralgia. *Scientific Reports*, *16*(1), 13202. https://doi.org/10.1038/s41598-026-42746-y

Tesarz, J., Hoheisel, U., Wiedenhöfer, B., & Mense, S. (2011). Sensory innervation of the thoracolumbar fascia in rats and humans. *Neuroscience*, *194*, 302–308. https://doi.org/10.1016/j.neuroscience.2011.07.066

Tozzi, P. (2015). A unifying neuro-fasciagenic model of somatic dysfunction—Underlying mechanisms and treatment—Part I. *Journal of Bodywork and Movement Therapies*, *19*(2), 310–326. https://doi.org/10.1016/j.jbmt.2015.01.001

Valenzuela, S., Miralles, R., Ravera, M. J., Zúñiga, C., Santander, H., Ferrer, M., & Nakouzi, J. (2005). Does head posture have a significant effect on the hyoid bone position and sternocleidomastoid electromyographic activity in young adults? *Cranio*, *23*(3), 204–211. https://doi.org/10.1179/crn.2005.029

Venne, G., Rasquinha, B. J., Kunz, M., & Ellis, R. E. (2017). Rectus capitis posterior minor: Histological and biomechanical links to the spinal dura mater. *Spine*, *42*(8), E466–E473. https://doi.org/10.1097/BRS.0000000000001867

Vilensky, J. A., Baltes, M., Weikel, L., Fortin, J. D., & Fourie, L. J. (2001). Serratus posterior muscles: Anatomy, clinical relevance, and function. *Clinical Anatomy*, *14*(4), 237–241. https://doi.org/10.1002/ca.1039

Vleeming, A., Pool-Goudzwaard, A. L., Stoeckart, R., van Wingerden, J. P., & Snijders, C. J. (1995). The posterior layer of the thoracolumbar fascia: Its function in load transfer from spine to legs. *Spine*, *20*(7), 753–758. https://doi.org/10.1097/00007632-199504000-00001

Vleeming, A., Schuenke, M. D., Masi, A. T., Carreiro, J. E., Danneels, L., & Willard, F. H. (2012). The sacroiliac joint: An overview of its anatomy, function and potential clinical implications. *Journal of Anatomy, 221*(6), 537–567. https://doi.org/10.1111/j.1469-7580.2012.01564.x

Vojta, V. (2008). *Die zerebralen Bewegungsstörungen im Säuglingsalter: Frühdiagnose und Frühtherapie*. Georg Thieme Verlag.

Vojta, V., & Peters, A. (2007). *Das Vojta-Prinzip: Muskelspiele in Reflexfortbewegung und motorischer Ontogenese* (3rd ed.). Springer. https://doi.org/10.1007/978-3-540-46524-9

Vostal, F. (2019). *Stabilizace axiálního systému v silovém tréninku* [Master's thesis, Masaryk University].

Vyskotová, J. (2013). *Speciální a aplikovaná kineziologie: Studijní opora k inovovanému předmětu Kineziologie 2*. Ostravská univerzita v Ostravě.

WHO Multicentre Growth Reference Study Group. (2006). WHO Motor Development Study: Windows of achievement for six gross motor development milestones. *Acta Paediatrica, 95*(Suppl. 450), 86–95. https://doi.org/10.1111/j.1651-2227.2006.tb02379.x

Wilke, J., Schleip, R., Yucesoy, C. A., & Banzer, W. (2018). Not merely a protective packing organ? A review of fascia and its force transmission capacity. *Journal of Applied Physiology, 124*(1), 234–244. https://doi.org/10.1152/japplphysiol.00565.2017

Willard, F. H., Vleeming, A., Schuenke, M. D., Danneels, L., & Schleip, R. (2012). The thoracolumbar fascia: Anatomy, function and clinical considerations. *Journal of Anatomy, 221*(6), 507–536. https://doi.org/10.1111/j.1469-7580.2012.01511.x

Wong, D. T., Weng, H., Lam, E., Song, H.-B., & Liu, J. (2008). Lengthening of the trachea during neck extension: Which part of the trachea is stretched? *Anesthesia & Analgesia, 107*(3), 989–993. https://doi.org/10.1213/ane.0b013e31817ef177

Yahia, L. H., Rhalmi, S., Newman, N., & Isler, M. (1992). Sensory innervation of human thoracolumbar fascia: An immunohistochemical study. *Acta Orthopaedica Scandinavica, 63*(2), 195–197. https://doi.org/10.3109/17453679209154822

Zafeiriou, D. I. (2004). Primitive reflexes and postural reactions in the neurodevelopmental examination. *Pediatric Neurology, 31*(1), 1–8. https://doi.org/10.1016/j.pediatrneurol.2004.01.012

Zafeiriou, D. I., Tsikoulas, I. G., Kremenopoulos, G. M., & Kontopoulos, E. E. (1998). Using postural reactions as a screening test to identify high-risk infants for cerebral palsy: A prospective study. *Brain & Development, 20*(5), 307–311. https://doi.org/10.1016/S0387-7604(98)00036-9

Zhuang, J., Gong, J., Hack, G. D., Chi, Y.-Y., Song, Y., Yu, S.-B., & Sui, H.-J. (2022). A new concept of the fiber composition of cervical spinal dura mater: An investigation utilizing the P45 sheet plastination technique. *Surgical and Radiologic Anatomy, 44*(6), 877–882. https://doi.org/10.1007/s00276-022-02962-3

Zimny, M. L. (1988). Mechanoreceptors in articular tissues. *American Journal of Anatomy, 182*(1), 16–32. https://doi.org/10.1002/aja.1001820103

Živný, B. (2026a). Persistent Afferent Bias: A mechanistic link between somatic disruption and autonomic dysregulation. *Frontiers in Integrative Neuroscience, 20*, 1848233. https://doi.org/10.3389/fnint.2026.1848233

Živný, B. (2026b). Somato-Psychic Pathway: A universal developmental trajectory linking somatic structural–functional integrity, autonomic regulation, and the emergence of mind. *Frontiers in Integrative Neuroscience, 20*, 1771123. https://doi.org/10.3389/fnint.2026.1771123

Živný, B., & Živná, V. (2026). *Axial block (AxB): A position paper on definition, terminology, and pathophysiology* (SPP Institute Position Papers, No. 1). NeuroCentrum. https://doi.org/10.5281/zenodo.22050239