Ergonomics in Neurosurgery

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Ergonomics is the science of designing and arranging objects, environments, and systems to optimize human well-being, comfort, safety, and performance. It focuses on creating a fit between people, their tasks, and the physical and cognitive demands of their work or living spaces. The goal of ergonomics is to enhance efficiency, productivity, and overall user satisfaction while minimizing the risk of injuries or discomfort. Here are some key points about ergonomics:

Physical Ergonomics: Physical ergonomics focuses on the interaction between people and their physical environment, including workstations, tools, equipment, and furniture. It aims to ensure that these elements are designed to fit the human body's capabilities, promoting good posture, reducing muscle fatigue, and minimizing the risk of musculoskeletal disorders.

Cognitive Ergonomics: Cognitive ergonomics examines the mental processes involved in tasks, such as perception, attention, memory, decision-making, and workload management. It aims to design systems and interfaces that align with human cognitive abilities, facilitating efficient information processing, decision-making, and task performance.

Organizational Ergonomics: Organizational ergonomics focuses on the optimization of social and organizational factors in the workplace. It considers aspects such as work scheduling, teamwork, communication, job design, and work environment to enhance productivity, job satisfaction, and employee well-being.

Principles of Ergonomics: Ergonomics principles guide the design and evaluation of workspaces and systems. Some key principles include:

Anthropometry: Designing for the range of body sizes and dimensions to accommodate different individuals.

Posture and Movement: Promoting neutral body postures and minimizing repetitive or awkward movements to reduce strain and fatigue.

Force and Load: Minimizing excessive force requirements and designing tools and equipment to distribute loads appropriately.

Visibility and Lighting: Optimizing lighting conditions, minimizing glare, and ensuring adequate visibility to reduce eye strain and improve task performance.

Workstation Design: Adjusting workstation layout, height, and arrangement of tools and equipment to suit the user's needs and promote comfortable and efficient work.

Information Display and Interface Design: Designing displays, controls, and interfaces to be intuitive, user-friendly, and efficient, considering human perception and cognitive capabilities.

Applications of Ergonomics: Ergonomics principles are applied in various domains, including workplaces, product design, transportation systems, healthcare settings, home environments, and digital interfaces. They are used to improve workstations, tools, equipment, vehicles, consumer products, and user interfaces to enhance safety, performance, and user satisfaction.

Benefits of Ergonomics: Applying ergonomic principles can lead to several benefits, including:

Reduced Risk of Injuries: Ergonomic design minimizes the risk of musculoskeletal disorders, repetitive strain injuries, and other work-related injuries.

Enhanced Comfort and Well-being: Ergonomically designed environments and systems promote comfort, reduce fatigue, and contribute to overall well-being and job satisfaction.

Increased Productivity: Optimizing workspaces and systems improves efficiency, reduces errors, and enhances task performance and productivity.

Cost Savings: Ergonomic design can lead to reduced healthcare costs, decreased absenteeism, and improved employee retention, resulting in long-term cost savings for organizations.

By integrating ergonomics principles into design processes, organizations and individuals can create more user-friendly, safe, and efficient environments, systems, and products that enhance human performance, comfort, and well-being.

Ergonomics is the study of how people interact with their work environment, including the physical, cognitive, and organizational aspects of work. The goal of ergonomics is to optimize the design of workspaces, tools, and tasks to improve comfort, safety, and productivity while minimizing the risk of injury or discomfort.

Ergonomics considers a wide range of factors, including the physical demands of a job, the layout and design of workspaces and equipment, the cognitive demands of tasks, and the social and organizational aspects of work.

Some examples of ergonomic considerations in the workplace might include the design of chairs and desks to reduce strain on the back and neck, the positioning of computer monitors to reduce eye strain and neck pain, and the use of tools and equipment that are easy to grip and manipulate without excessive force or awkward postures.

By optimizing the work environment for the needs of employees, ergonomic design can improve both individual well-being and organizational performance, reducing absenteeism, injuries, and errors, while increasing job satisfaction and productivity.

Musculoskeletal disorders are common among surgeons and affect most neurosurgeons over the course of their careers. Although all subspecialist neurosurgeons may be affected by physical strain, spine surgeons and skull base surgeons have a high propensity for workplace injury as a result of long procedures with repetitive movements in strained physical positions.

In a review, the prevalence of musculoskeletal disorders in neurosurgery, the state of innovation to improve ergonomics in the operating room for neurosurgeons, and potential limitations in advancing technology with the goal of maximizing neurosurgeon longevity are discussed.

Innovations such as robotics, the exoscope, and handheld devices with more degrees of freedom have allowed surgeons to maneuver instruments without exerting excessive effort, all while maintaining neutral body positioning, and avoiding joint and muscle strain.

As new technologyand innovation in the operating room develop, there has been a larger emphasis placed on maximizing surgeon comfort and neutral positioning, by minimizing force exertion and fatigue [1].

Since its clinical implementation, microvascular surgery has depended on the continuous improvement of magnification tools. One of the more recent developments is a high-definition three-dimensional (3D) digital system (exoscope), which provides an alternative to state-of-the-art operating microscopes. This study aimed to evaluate the advantages and disadvantages of this technology and compare it with its predecessor. The study included 14 surgeons with varying levels of experience, none of which had used a 3D optical system previously. Six of these surgeons performed five arterial and five venous anastomoses in the chicken thigh model with both the VITOM 3D exoscope-guided system and the Pentero operating microscope. These anastomoses were then evaluated for their quality and anastomosis time. The participants and the other eight surgeons, who had used the digital 3D camera system for microsurgical training exercises and vascular sutures, answered a questionnaire. The anastomosis time and number of complications were lower with the conventional microscope. Participants rated the image quality with the conventional microscope as higher, whereas the field of view and ergonomics were favorable in the digital 3D camera system. Exoscopes are optics suitable for performing simple microvascular procedures and are superior to classical microscopes ergonomically. Thus far, they are inferior to classical microscopes in terms of image quality and 3D imaging [2]

Six neurosurgeons performed micro-surgical procedures on cadaveric specimens using the prototype of a digital 3D exoscope system (Aeos®, Aesculap, Tuttlingen, Germany) and a standard operating microscope (Pentero 900, Zeiss, Oberkochen, Germany) at two different patient positions (semisitting (SS), supine (SP)). The activities of the bilateral upper trapezius (UTM), anterior deltoid (ADM), and lumbar erector spinae (LEM) muscles were recorded using bipolar surface electromyography and neck flexion, arm abduction, and arm anteversion angles by gravimetrical posture sensors. Perceived discomfort frequency was assessed and subjects compared the two systems in terms of usability, posture, physical and mental demands, and working precision. Using the exoscope led to reduced ADM activity and increased UTM and LEM activity during SS position. The neck was extended when using the exoscope system with lower arm anteversion and abduction angles during the SS position. Subjects reported discomfort at the shoulder-neck area less frequently and lower physical demands when using the Aeos®. However, mental demands were slightly higher and two subjects reported lower working precision. The exoscope system has the potential to reduce the activity of the ADM by changing surgeons arm posture which may be accompanied by less discomfort in the shoulder-neck area. However, dependent on the applied patient position higher muscle activities could occur in the UTM and LEM [3].

1)

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2)

Fichter AM, Wolff CT, Grabenhorst A, Koss LH, von Bomhard A, Nieberler M, Wolff KD, Ritschl LM. Comparison of a high-definition three-dimensional digital camera system with a conventional state-of-the-art operation microscope for microsurgical anastomoses. Sci Rep. 2023 Jul 5;13(1):10867. doi: 10.1038/s41598-023-37530-1. PMID: 37407612; PMCID: PMC10322850.

3)

Steinhilber B, Conte L, Seibt R, Herlan S, Tatagiba M, Ebner FH. Musculoskeletal demands in microsurgery-an explorative study comparing the ergonomics of microscope and 3D exoscope. Neurosurg Rev. 2023 Jul 4;46(1):164. doi: 10.1007/s10143-023-02076-3. PMID: 37402848.