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RULA method in the ergonomic analysis of an ophthalmic surgeon's work: a case study

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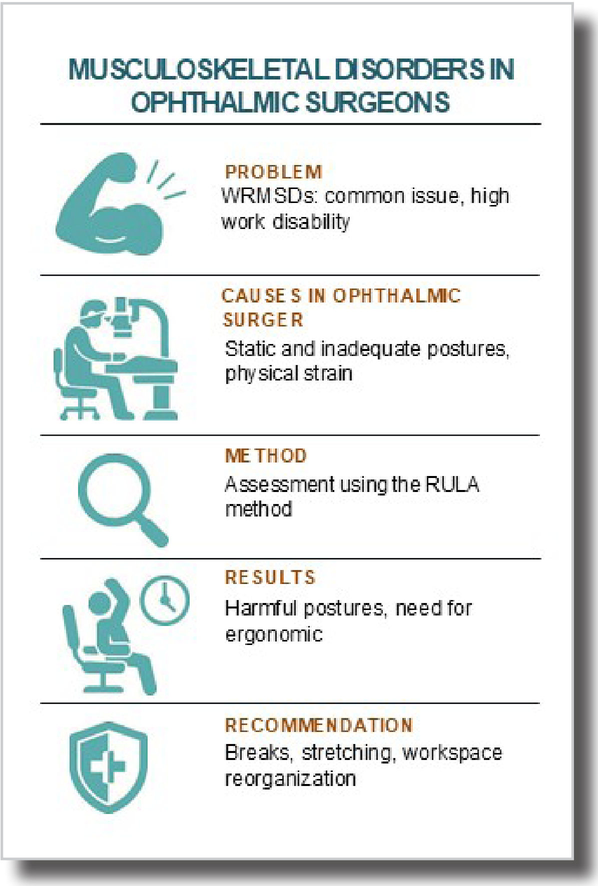
Graphical abstract



Highlights

- *Work-related musculoskeletal disorders (WRMSDs) are common, especially among ophthalmic surgeons, due to static postures and repetitive movements.*
- *The RULA method was used to analyze the surgeon's posture during surgeries, identifying a moderate postural risk.*
- *Recommended ergonomic measures include proper posture (back support, feet firmly on the floor, elbows close to the body), the use of adjustable chairs, and technologies that reduce forward leaning.*
- *Many surgeons show low ergonomic awareness, having received little training on the subject.*

Abstract

Work-related musculoskeletal disorders (WRMSDs) represent a widespread occupational health issue across many countries, leading to high organizational costs and constituting one of the main causes of work disability. Ophthalmic surgery requires a high level of concentration, precision, and physical effort, often associated with the adoption of static and inadequate postures, which predispose these professionals to the development of WRMSDs. This study aimed to characterize the posture of an ophthalmic surgeon in the operating room using the RULA (Rapid Upper Limb Assessment) method. This is a descriptive case study conducted according to the Case Report (CARE) guidelines. The results revealed that the surgeon remains seated and static for extended periods, adopting potentially harmful postures. The application of the RULA method indicated an urgent need for ergonomic intervention, with recommendations including seat adjustments, arm support, and workspace reorganization. The importance of implementing regular breaks, stretching exercises, and strategies to reduce visual fatigue is also emphasized. The use of more comprehensive, complementary ergonomic assessment methods is recommended for a more complete analysis. It is concluded that ergonomic adaptation of the workstation is essential for promoting the surgeon's health, safety, and performance, and that the RULA method is a valuable tool for identifying risks associated with WRMSDs.

Keywords: Musculoskeletal Diseases. Ophthalmologic Surgical Procedures. Occupational Health Nursing. Ergonomics.

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INTRODUCTION

Work-related musculoskeletal disorders (WRMSDs) are a recurring occupational health problem across various sectors. These disorders can affect different parts of the body, such as the shoulders, neck, spine, knees, wrist, or hand.

According to Mota *et al.*[1], during surgery, the repetition of movements under stress, the demand for motor control and near visual focus, and the prolonged maintenance of inadequate postures contribute to the onset of musculoskeletal pathologies.

To ensure that tasks are performed safely and comfortably, it is essential to apply ergonomic principles, addressing both workers' posture and the suitability of the equipment used.

Several studies have reported WRMSDs as a significant occupational health issue among ophthalmic surgeons[1,2,3]. A more recent study highlights a strong association between musculoskeletal pain and the amount of time spent performing surgery[4].

Ophthalmic surgery requires high motor precision and concentration, forcing surgeons to maintain prolonged static postures and to perform repetitive upper limb movements throughout the workday[5].

The adoption of good practices, such as regular breaks, workplace exercise programs, physical activity, teamwork, and spatial organization, is essential to optimize ergonomic conditions and promote workplace well-being.

A poorly designed workstation, combined with inadequate postures during task execution, can significantly contribute to the development of musculoskeletal injuries (MSIs).

In the European Union, data from 28 member states show that, in 2015, approximately 43% of workers reported lower back pain, around 41% reported muscle pain in the upper limbs, and about 29% reported muscle pain in the lower limbs[6].

These and other types of WRMSDs can lead to a decreased quality of life - potentially becoming the main reason for early retirement - as well as productivity loss and absenteeism, resulting in costs for organizations[6,7].

Currently, it is known that the field of ophthalmic surgery also presents a high risk of developing musculoskeletal disorders[4].

The general objective of this study is to analyze the postures adopted by the ophthalmic surgeon through an Ergonomic Work Study (or workstation analysis), using the RULA method during surgical procedures. The study aims to answer the following research question:

Does the posture of the ophthalmic surgeon, while performing activities in the operating room, represent an ergonomic risk for the development of WRMSDs?

The specific objectives are: to describe the postures of the ophthalmic surgeon during surgical procedures using the RULA method; to identify the factors that may influence the surgeon's posture; and to propose recommendations to improve the ergonomic conditions of the ophthalmic surgeon's workstation.

METHODOLOGY

This is a descriptive study with a case study approach, cross-sectional in nature and situated within the positivist paradigm. It describes and evaluates, using the RULA method, the posture of a 38-year-old ophthalmologist who regularly performs surgeries in the operating room of a hospital under the Lisbon and Tagus Valley Regional Health Administration, with a minimum of 24 hours of surgical activity per week.

This operating room hosts an ophthalmology program designed to provide timely and comprehensive care for complex and highly specialized cases at both national and international levels.

During a typical 8 a.m. to 4 p.m. shift, multiple surgeries may be performed, interspersed with breaks, although these intervals may be very short or even nonexistent.

Postural data concerning the ophthalmic surgeon were obtained through direct observation of local conditions and equipment. This was followed by the use of the *Ergolândia* software - an ergonomic tool available to professionals (ergonomists, physiotherapists, and workplace specialists) for evaluating employee ergonomics. Several assessment methods are available within the platform, including the NIOSH Method (National Institute for Occupational Safety and Health, USA), OWAS (Ovako Working Posture Analysis System), OCRA Checklist (Occupational Repetitive Actions Checklist), RULA Method, REBA Method (Rapid Entire Body Assessment), among others.

For this intervention, the RULA method was selected, as it evaluates workers' exposure to risk factors associated with their working postures[8]. The RULA method assesses postures in two groups: the group comprising the upper arms, lower arms, wrists, and wrist rotation, and the group comprising the neck, trunk, and legs[9].

Despite its practical applicability and ease of use, the RULA method presents notable limitations, particularly due to its emphasis on static postures and its failure to account for important factors such as vibration, dynamic load, work pace, visual fatigue, extreme temperatures, finger movements, and hand-applied pressure, elements that are especially relevant in the context of ophthalmic surgery, where the prolonged use of microscopes and fine instruments demands high motor precision and continuous visual focus. Therefore, the inclusion of complementary methods, such as REBA, or instrumental techniques such as electromyography, is recommended for a more comprehensive assessment[10,11].

Additionally, this study addresses visual fatigue only briefly, despite it being a critical factor for ophthalmic surgeons who are exposed to long periods of work under the microscope. Ocular fatigue can impair surgical performance and contribute to discomfort and errors. Future studies are encouraged to include specific metrics for visual fatigue, such as validated questionnaires (e.g., the Visual Fatigue Index – VFI), as well as objective evaluations, including continuous exposure time and eye-specific rest intervals that promote visual recovery during shifts[12].

The angulation values for limbs and spine were assigned based on the visual logic proposed by the *Ergolândia* 7.0 software. By combining the program's predefined positions with the observations made on-site, the values considered in this case study were determined. Based on the results obtained, several conclusions were drawn, and preventive measures were proposed to minimize the risk of musculoskeletal injury.

The ergonomic recommendations, such as chair adjustments, lateral arm supports, and workspace organization, are grounded in evidence from the literature[13]. However, this study did not test the practical effectiveness of these interventions in the real operating room context. To strengthen the conclusions, future studies should include pre- and post-intervention comparative assessments, using objective metrics of comfort, posture, and performance, as well as direct feedback from the surgeons themselves[14]. Such an approach would validate the usefulness and feasibility of the interventions in actual work environments.

It is acknowledged that the analysis was conducted on a single subject, which limits the generalizability of the results. To enhance the external validity of the study, future research should include a broader sample of ophthalmic surgeons from different hospital units, with variability in working conditions and operating room setups. This approach would enable the identification of common patterns and specific ergonomic needs with greater statistical robustness[15].

Throughout the entire analysis, the ethical principles of scientific research were respected. Confidentiality and anonymity of the data were ensured, as well as the participant's voluntary and informed participation and self-determination. The study complies with ethical guidelines for health research.

RESULTS

The ophthalmologist's height is approximately 1.64 meters. The surgical stretcher on which the patient is placed is approximately 76 cm high, while the stool used by the surgeon has a height of 60 cm, and the footrest is 13 cm high (Table 1). To the surgeon's right side, there is an auxiliary table measuring 86 cm in height, which holds the materials used during the procedure—handed to the surgeon by the scrub nurse.

The ophthalmic surgeon operates in a seated position, maintaining a static posture throughout the entire surgical procedure.

Table 1 - Results of direct observation of the ophthalmologist during surgery, in the Operating Room of the Regional Health Administration Hospital of Lisbon and Tagus Valley, 2025.

	Height from the floor
Patient stretcher	76cm
Surgeon's stool	60cm
Footrest	13cm
Backrest (stool + extension)	60+12cm

Source: Own elaboration. Note: Measurements refer to the height of the main equipment used by the ophthalmologist during surgery.

The position of the surgeon's arm, based on shoulder angle, is in extension—at approximately 0°. The trunk is also in extension and subjected to considerable tension, as it serves as the support base for the simultaneous coordination of the head (focused on the microscope), upper limbs (holding surgical instruments), and lower limbs (operating the microscope and ultrasound pedals)[1].

Over time, it was observed that the head tends to tilt slightly forward, reaching a flexion angle of up to 10°, prompting the ophthalmologist to readjust the height of the microscope.

The ophthalmologist maintains neck extension for most of the procedure, with a maximum flexion of up to 10°. This position is necessary to visualize the patient's eye through the microscope and to monitor the precision of the instruments in use. The surgery is delicate and requires meticulous hand movements, demanding a high level of attention and concentration.

Occasionally, the surgeon rotates their head to the right to confirm instrument positioning, although this is infrequent, as the scrub nurse usually hands the required tools directly.

Regarding forearm position, based on the elbow angle, the surgeon maintains a flexion between 60° and 100°. Although lateral supports for the forearms are available, they were not used consistently throughout the procedure.

Wrist position: The surgeon's wrist remains in either flexion or extension between 0° and 15°, with rotation.

Foot position: The feet are well supported and stable. The footrests are aligned with the feet, and there is a pedal on the right side, which is used during certain surgeries.

The chair features a backrest and height adjustment to allow each user to work at a vertical level suited to their stature. It also has lateral supports to rest the upper limbs: arms, forearms, and wrists.

Using the RULA method via the *Ergolândia* software, the results presented in Table 2 were obtained. The postural analysis results serve as the basis for determining the appropriate action level to be taken. For the activity performed by the ophthalmic surgeon, a RULA score of 3 or 4 was identified, corresponding to Action Level 2, indicating that posture should be observed and changes may be needed.

Table 2 - Results of the RULA Method Application in the Operating Room of the Regional Health Administration Hospital of Lisbon and Tagus Valley, 2025.

Assessment	Result
GROUP A	
Arm	20° extension to 20° flexion
Forearm	60° to 100° flexion
Wrist	0° to 15° flexion or extension, or full pronation or supination
	External rotation
GROUP B	
Neck	0° to 10° flexion
Trunk	0° or well supported when seated
Legs	Legs and feet well supported and balanced
Activity	Static posture maintained for more than one minute, or repetitive posture more than 4 times per minute
Final score	3
Action level	2

Source: Own elaboration. Note: Results of ergonomic assessment using the RULA method, which evaluates postural risk across different muscle groups during surgical activity.

DISCUSSION

The posture of an ophthalmic surgeon was evaluated while performing professional activities. The observation revealed that the posture adopted could be modified and improved. For most of the working time, the surgeon maintained a static posture with both upper and lower limbs. A seated position was used during the surgical procedures.

Although the RULA method offers practical applicability and is effective for quickly identifying postural risks, it has important limitations. It assesses postural load in a momentary manner, based on a single representative posture of the task, and does not reflect postural variability over time nor account for dynamic factors[16]. Furthermore, RULA does not include contextual variables such as work pace, cognitive load, prolonged exposure time, vibration, or ambient temperature, all of which can exacerbate ergonomic risks[17].

In this regard, the use of complementary methods is advisable. For example, the REBA method is more sensitive to dynamic task analysis and places greater emphasis on the lower limbs and postural variations; the OCRA checklist is suitable for repetitive tasks involving the upper limbs; and surface electromyography allows for quantifying muscle activity and identifying peaks of static or repetitive exertion[18,19].

Combining RULA with one or more of these methods may provide a more comprehensive and reliable assessment of the physical demands involved in ophthalmic surgery.

To minimize these impacts, it is essential to adopt proper ergonomic posture, keeping the back relatively straight and well supported by the chair backrest, thighs parallel to the floor forming a 90-degree angle with the legs, feet resting on the floor, and elbows close to the body[20].

The introduction of new surgical equipment with high-definition screen visualization and 3D glasses technology allows the surgeon to direct their gaze toward a monitor, eliminating the need to lean over a microscope. This innovation offers greater freedom of movement and contributes to a more ergonomic posture[21].

Moreover, measurable benefits have been reported following the implementation of ergonomic recommendations. Studies conducted with surgeons who began using seats with adjustable support, forearm rests, and front-facing monitors showed a significant reduction in RULA scores[22].

To reduce physical overload, it is essential to alternate postures regularly. Whenever possible, workplace exercise routines should be performed during the workday. This practice consists of a sequence of specific exercises tailored to each task and should be integrated into the workplace environment to prevent injuries and promote employee well-being. Taking periodic breaks is also crucial. Short interruptions throughout the workday help improve concentration, stimulate creativity, and reduce stress levels. These breaks not only help prevent musculoskeletal problems but also minimize the effects of visual fatigue.

Visual fatigue is a common complaint among professionals performing tasks that demand high ocular effort and intense visual concentration, such as ophthalmic surgeons. It manifests through symptoms like blurred vision, dry eyes, burning sensation, headaches, and difficulty focusing[23].

To mitigate visual fatigue, several effective strategies are recommended. One of them is the 20-20-20 rule, which consists of looking at a point approximately 6 meters away for 20 seconds every 20 minutes, allowing the eye muscles to rest and reducing strain[24]. It is also important to use indirect and adjustable lighting to avoid glare and reflections that may interfere with the visual field. Regular eye lubrication, especially in air-conditioned environments, is essential to prevent discomfort associated with dry eyes.

For professionals who use monitors, it is important that these have good resolution and contrast, to avoid eye strain. Taking visual breaks between surgeries helps the eye muscles to relax, reducing visual fatigue[23].

The implementation of these measures into the daily routine of healthcare professionals, as well as their integration into occupational health programs, is essential to preserve visual acuity, ensure surgical precision, and maintain patient safety by preventing the negative effects of visual fatigue.

Thus, we consider the following aspect to warrant "observation":

Seating ergonomics

Undoubtedly, for this ophthalmologist, the design of the seat/chair influences the type of posture adopted. The presence of lateral arm supports is also important, as ophthalmic surgeons must handle extremely delicate instruments, which requires considerable hand strength to perform fine and precise movements over extended periods.

According to Feng *et al.*[25], supporting the arms and forearms reduces the load on the shoulders and lessens the amount of force needed to execute movements, thereby reducing fatigue. Similarly, Milerad and Ericson[26] demonstrated in their study the importance of forearm support in reducing muscle load in the trapezius, supraspinatus, and deltoid muscles. Although the chair used by this ophthalmologist had lateral supports, they were not used for short periods. Keeping the arms suspended transfers static force to the shoulders, potentially leading to shoulder injuries.

The vertical height of the seat must be adjusted for each individual. In the case analyzed, the seat and backrest height were considered properly adjusted to the ophthalmologist's stature.

Postural balance between the worker and the working surface and/or table

Work equipment must be organized within the worker's field of vision, thereby minimizing excessive head rotation[3]. The patient's positioning is also crucial for the ophthalmologist's approach. The ideal position for this type of surgery is the supine position, with the patient lying horizontally, allowing the surgical field to be aligned with the surgeon's elbow level.

By elevating and adjusting the patient's stretcher to the surgeon's height, there is no need to bend or strain the upper limbs. If the stretcher is not properly aligned, with incorrect limb angulation, it may cause not only shoulder pain but also carpal tunnel syndrome and even tendinitis[3].

In this case, the ophthalmologist did not perform excessive movements or upper limb flexions to reach the patient. Initially, the surgeon made sure to sit on the chair and adjust it to their height, and only then adjusted the microscope and stretcher height.

This prior preparation by the surgeon contributes to better performance in the execution of the procedure. As for the instrument table, it was positioned on the right side, allowing the scrub nurse to hand over the instruments directly, avoiding the need for head rotation.

Lower limb support

For most of the time, the ophthalmologist's lower limbs are well supported and balanced. Only during the use of the pedal does foot support become asymmetric, as one foot is fully supported while the other presses the heel to activate the pedal. Since these periods are short, in the RULA assessment, the legs and feet were considered well supported. It is worth noting that the pedal is positioned nearby, requiring minimal effort to operate.

Literature recommends that the pedal be close to one of the feet, avoiding lateral movements, and that footrests be used, with the knees slightly flexed at an angle greater than 90°[27].

It is advisable to alternate foot positioning during clinical practice to vary the workload on the hip and spine muscle groups, promoting tissue oxygenation and thereby reducing the risk of muscular fatigue.

Undoubtedly, the static or postural load of this profession is a key factor to consider in the evaluation of working conditions. Reducing exposure time to these conditions is one of the main actions for improving these workstations.

However, few surgeons recognize that their posture is incorrect, nor are they aware of the best posture to adopt. In the study conducted by Kaup *et al.*[28], with ophthalmologists, the lack of awareness among these professionals was also evident, with only 27.9% of participants having attended lectures or read literature on ergonomics in ophthalmologic practice.

In this case study, the duration of the activity, the static posture with trunk extension, and the precise hand movements are among the factors contributing to the risk of developing MSDs.

The RULA method is useful for evaluating posture before and after corrective measures, equipment adjustments, and as a pedagogical tool for training workers. However, it has limitations, as it only analyzes static postures and does not account for temporal, biomechanical, or psychosocial factors. In the studied location, this evaluation had never been performed, and no breaks or workplace exercise routines were in place.

The analysis revealed risk levels that justify interventions to prevent musculoskeletal injuries. Although RULA is practical, it is recommended that it be combined with other methods for a more comprehensive evaluation. Implementing breaks, exercises, ergonomic adjustments, and strategies to reduce visual fatigue is essential. Awareness and occupational health programs are crucial to improving the health and work quality of these professionals.

CONCLUSION

The results of this study clearly highlight the need for ergonomic adaptation of workstations to promote professionals' well-being. The implementation of good ergonomic practices contributes to reducing physical discomfort, improving quality of life at work, and increasing productivity.

The use of assessment tools such as the RULA method proves useful due to its simplicity and applicability in real contexts, allowing for the quick identification of risk postures. This study reinforces the importance of RULA not only as an assessment tool but also as a pedagogical instrument that raises awareness among professionals regarding their postures and working conditions.

However, it is essential to acknowledge the limitations of this method and to complement it with broader approaches, especially for the evaluation of dynamic tasks, muscle load, and visual fatigue — aspects often overlooked, yet directly impacting the professional's health and performance. Visual fatigue, in particular, deserves greater attention due to its high prevalence and its influence on visual acuity and surgical precision.

Occupational Health Nurses must act proactively in prevention, education, and worker support, promoting safe and healthy work environments based on scientific evidence. In accordance with Regulation No. 372/2018[29], they are responsible for identifying, assessing, and managing occupational risks, ensuring specialized care management focused on workers' well-being and performance, and playing a key role in health promotion and protection in the workplace.

Raising ophthalmologists' awareness regarding correct posture and healthier work habits is essential to preventing musculoskeletal injuries and visual fatigue, thus reducing absenteeism and fostering safer, more effective clinical practice.

It is therefore imperative to develop further studies with this type of integrated approach, combining on-site observation with the application of objective evaluation methods, and promoting an occupational health culture grounded in evidence and centered on the protection and appreciation of those who care.

CRediT author statement

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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