Assessment of interns and postgraduate dental student’s knowledge regarding equipment ergonomics

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ABSTRACT

Context: The substantial knowledge concerning ergonomics and its practical application is vital for forestalling musculoskeletal disorders. The role of equipment ergonomics (EE) in preventing these work-related ailments is significantly noteworthy.

Aim: The aim of the study was to assess the prevailing perception of postgraduates (PGs) and interns regarding EE and preparing the Indian dental workforce for the challenges of India’s growing economy and population.

Settings and Design: Authors conducted a cross-sectional survey between December 2013 and February 2014 amidst the interns and PG dental students of Davangere city, Karnataka, India.

Subjects and Methods: The data were collected using 21-item custom designed proforma, comprising of questions evaluating student’s basic knowledge about EE.

Statistical Analysis Used: Statistical analysis was done using Chi-square test in each group (PGs and interns) and Mann–Whitney test was implemented for comparison between both groups.

Results: Of 358 subjects surveyed, 48% PGs and 52% interns affirmed that they came across EE only through this survey. In addition, 91.18% of PGs and 90.59% interns believed that the accentuation on EE is less in the current dental curriculum.

Conclusions: Comprehensive understanding and practical application of EE among the participants was found to be lacking. The importance of microbreaks and chair side exercises should be emphasized and training should be initiated at an early stage before improper postural habits develop.

Key words: Dental equipment, human engineering, musculoskeletal disease

It is a well-established fact that dental health care workers are more prone to work associated injuries and illness, which precipitates diminished work proficiency, risk of long-term disabilities, mental stress, psychosocial problems, abstinence from work, and related costs. Highly prevalent among these work related problems are the musculoskeletal injuries (MSIs) which ironically many a times are preventable.

Owing to the nature of work patterns which primarily have repetitive movements in a static position for an extended period, dental surgeon are at a high risk for developing MSI.

The same is exaggerated if combined with wrong postures, forceful movements, and poorly designed equipment. In a systematic review, 64–93% of dentists were suffering from MSI and among the affected dentists, only 32% were found to seek medical help, reflecting the negligence of these crucial injuries.

Equipment design plays a dominant role in modulating these work-related stresses, and ergonomically designed instruments can prevent many such associated problems. In spite of exponential advancement occurring in the dental equipment designs, numerous times the dentist are known to select instruments based on familiarity rather than the

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Dental student’s perspective on equipment ergonomics. The efficacious solicitation of equipment ergonomics (EE) assures high productivity, avoidance of illnesses and injuries, and amplified satisfaction among workers.

Comprehensive understanding and practice of EE by the budding dental students are decisive for interception of the dentistry related health concerns. If principles of EE are not properly stressed upon and followed in the early formative years of dental education, it is highly improbable that it will be followed later during their clinical practice. To the best of author’s knowledge, there are no other studies in the literature assessing the dental student’s knowledge on EE. Hence, the objective of the current cross-sectional survey is to evaluate the dental student’s knowledge regarding EE.

SUBJECTS AND METHODS

The study design was a cross-sectional, coded, area-framed, self-administered, double-blinded questionnaire survey, conducted between December 2013 and February 2014. The study population comprised of the dental postgraduates (PG) and interns of Davangere city, Karnataka, India. Total sample or the whole target population constituted the sample. The interns who participated in the survey have completed 4 years of undergraduate dental education and are now in the 5th clinical year of education. The students unwilling to participate were excluded from the study. Ethical clearance was attained from Institutional Review Board, (reference number. BDC/Exam/393/2013-2014). Informed consent from participants was taken prior to the commencement of the survey. Authors used a 21-itemed, custom designed, nominal-polytomous closed-ended, and check listed questionnaire developed based on various literature sources. For ease of understanding, the questionnaire was divided into three parts; part 1 bearing questions on basic knowledge regarding EE, part 2 on knowledge in relation to exercises and microbreaks and part 3 on suggestions of the participants regarding timely change of pattern in dental curriculum.

The validation of the questionnaire was regulated and supervised by means of face validation, content validation, reliability, and consistency tests. Five subject experts were selected, and the content validation was executed. Before the data collection, a pilot test was conducted to eliminate intra-responder variability with a sample size of 20 to pretest the questionnaire and Cohen’s kappa coefficient was estimated as 0.925, reflecting almost perfect agreement with the questionnaire. Data collection mode utilized was face to face approach with paper and pencil interviewing method. The data were coded, tabulated, and analyzed using Statistical Package for Social Sciences (SPSS statistics version 13.0) software. The data were tested for normality using Anderson–Darling test. Since the data did not follow normality, nonparametric tests were used to determine statistical significance. The level of significance was fixed at 5% (α = 0.05). Chi-square test was adopted to assess whether there were any statistical significances in the responder’s knowledge with a significance level of P ≤ 0.05 [Table 1]. Four questions have been graphically illustrated [Graphs 1-4]. Between the two groups (PGs and interns), Mann–Whitney test was implemented to correlate the total mean scores [Table 2].

RESULTS

The questionnaire was filled by a total of 373 participants which included 71.50% interns and 28.49% of PG students. The questionnaire focused on the following segments: Dental chair, operator stool, hand instruments, lighting and magnification loupes, and advanced instruments ergonomics.

With the Mann–Whitney test, higher mean score were recorded in PG students (14.85) compared to that of interns (13.65) and the difference between them were found to be statistically significant (P < 0.001). The mean difference was computed as 1.206 and 95% confidence interval for the same was 0.480 (lower bound) and 1.932 (upper bound).

Relative to which equipment requires EE, the answer included dental chair, operator light, dental handpiece, syringes, hand instruments, gloves, while the minority responded that all the above-mentioned instruments require EE. Mainstream responders claimed that dental chair ergonomics is desired for operator’s neutral position, and it maximizes the accessibility and visibility for the dental surgeon throughout the procedure. In addition, adjustment of the operator stool and the positioning of hips in relation to knees during the dental procedures, finding was that hips should be kept slightly above the knees. The lightweight instruments reduce the muscular workload, and the necessity of the dental surgeons taking microbreaks to reduce excessive muscle fatigue was stressed upon. However, regarding usage of chair side exercises in their clinical practice, only a minority affirmed that they have practiced it.

DISCUSSION

Ergonomics is the discipline of fitting workplace conditions and job demands to the capabilities of the working population. When smeared to dentistry, ergonomics pursues to diminish cognitive and physical stress, avert occupational diseases linked to the practice of dentistry, and improve productivity, with enhanced quality and superior comfort for both the professional and the patient.

In the recent dental literature, MSI related terminologies are cropping up with an increased frequency, and its reported prevalence rate is remarkably high. It has been detected among dentists worldwide that low back problems are the most prevalent, followed by problems of the hand and wrist,
Table 1: Responses to questions about respondent’s knowledge regarding equipment ergonomics, by percentage of total respondents (n=358)

| Questions                                                                 | Percentage of PG response/interns response | \( \chi^2 \) | P |
|---------------------------------------------------------------------------|-------------------------------------------|---------------|---|
| Ergonomic principles apply only to clinician’s position, but not to equipment’s | Agree: 1.96/4.71, Disagree: 84.31/67.45, Maybe: 0.98/23.92, No idea: 12.75/3.92 | 35.150 | <0.001* |
| Do you consider that the musculoskeletal problems are not related to wrong equipment ergonomics? | Agree: 9.80/8.24, Disagree: 79.41/65.88, Maybe: 3.92/11.76, No idea: 6.86/14.21 | 10.008 | 0.018* |
| Dental chair ergonomics is not needed for maintaining the operator’s neutral position | Agree: 9.80/5.49, Disagree: 81.37/75.29, Maybe: 2.94/17.65, No idea: 5.88/1.57 | 18.925 | <0.001* |
| It maximizes patient accessibility and visibility for the dental surgeon during the procedure | Agree: 93.14/72.16, Disagree: 0.98/3.53, Maybe: 1.96/14.51, No idea: 3.92/9.80 | 19.400 | <0.001* |
| Should the operator chair height be adjusted so that hips are slightly higher than knees? | Agree: 38.24/14.90, Disagree: 24.51/18.04, Maybe: 32.35/52.55, No idea: 4.90/14.51 | 31.994 | <0.001* |
| New ergonomically designed operator stools such as saddle seats, tri-shaped seats etc., prevents low back pain | Agree: 64.71/81.18, Disagree: 1.96/2.75, Maybe: 14.71/6.67, No idea: 18.63/9.41 | 13.153 | 0.004* |
| Light weight instruments do not help to reduce muscle workload | Agree: 10.78/8.63, Disagree: 79.41/81.96, Maybe: 6.86/4.31, No idea: 2.94/5.10 | 2.120 | 0.548 |
| The sharp instruments are essential for reducing excessive forces during instrumentation | Agree: 93.14/93.73, Disagree: 2.94/1.96, Maybe: 0.98/3.53, No idea: 2.94/0.78 | 4.425 | 0.219 |
| Knurling (texturing) of instruments leads to poor grasp | Agree: 19.61/10.20, Disagree: 64.71/63.53, Maybe: 2.94/17.65, No idea: 12.75/6.63 | 18.003 | <0.001* |
| Is the precise angulation of the hand instruments and the accessibility to the operating area relevant? | Agree: 93.14/94.12, Disagree: 0.98/2.75, Maybe: 3.92/2.35, No idea: 1.96/0.78 | 2.560 | 0.465 |
| Poor fitting gloves can cause pain in the hands | Agree: 82.35/82.35, Disagree: 6.86/8.24, Maybe: 3.92/7.84, No idea: 6.86/1.57 | 8.469 | 0.037* |
| Proper operating light position is not a critical factor in producing an even, shadow free illumination | Agree: 6.86/11.97, Disagree: 89.22/63.53, Maybe: 0.00/10.98, No idea: 3.92/13.73 | 26.082 | <0.001* |
| Surgical loupes help the operator to maintain a neutral position while increasing the visual acuity and diagnostic ability | Agree: 84.31/82.75, Disagree: 0.98/1.18, Maybe: 2.94/4.31, No idea: 11.76/11.76 | 0.397 | 0.941 |
| Ergonomically designed rotary instruments are not effective in reducing treatment time and muscle fatigue | Agree: 6.86/5.49, Disagree: 82.35/89.02, Maybe: 1.96/2.75, No idea: 8.82/2.75 | 6.789 | 0.079 |
| Innovative ergonomic extraction kits like Benex have made extraction proceduresatraumatic, easy, and effective | Agree: 53.92/73.62, Disagree: 1.96/0.79, Maybe: 11.76/4.33, No idea: 32.35/21.26 | 14.936 | 0.002* |
| Lasers give us an ergonomic edge by reducing the treatment time and increasing patient as well as operator comfort | Agree: 85.29/84.71, Disagree: 0.00/1.18, Maybe: 6.86/7.84, No idea: 7.84/6.27 | 1.562 | 0.668 |
| Should the dental surgeon take microbreaks to reduce excessive muscle fatigue? | Agree: 62.75/27.45, Disagree: 1.96/2.35, Maybe: 1.96/5.49, No idea: 33.33/64.71 | 39.118 | <0.001* |
| Have you ever used chair side exercises in your clinical work? | Agree: 34.31/15.69, Disagree: 58.82/79.61, Maybe: 3.92/3.53, No idea: 2.94/1.18 | 17.686 | 0.001* |
| Emphasis about equipment ergonomics is less in the present dental curriculum | Agree: 91.18/90.59, Disagree: 1.96/2.75, Maybe: 2.94/3.14, No idea: 3.92/3.53 | 0.220 | 0.974 |
| It should be included as a separate entity in the syllabus before the students enter the clinic | Agree: 83.33/89.80, Disagree: 3.92/3.14, Maybe: 6.86/5.10, No idea: 5.88/1.96 | 4.552 | 0.210 |
| Improper equipment ergonomics and its related musculoskeletal problems should be properly emphasized in the curriculum | Agree: 93.14/92.94, Disagree: 0.98/1.96, Maybe: 0.98/3.14, No idea: 4.90/1.96 | 4.011 | 0.260 |

\*Significant difference. SD=Standard deviation, SE=Standard error, CI=Confidence interval

Table 2: Comparison of total score between PGs and interns using Mann–Whitney U-test

| Group | n | Mean | SD | SE of mean | Mean difference | 95% CI for mean difference | Z | P |
|-------|---|------|----|------------|-----------------|--------------------------|---|---|
| PG    | 102 | 14.85 | 3.56 | 0.35 | 1.206 | 0.480 | 1.932 | -4.280 | <0.001* |
| UG    | 255 | 13.65 | 2.97 | 0.19 |                |              |          |        |                |

\*Significant difference. SD=Standard deviation, SE=Standard error, CI=Confidence interval

neck and shoulders with more than one-third requiring medical care for MSIs and also requiring extended leave from their practice.\(^1\)\(^1\) Moreover, hand paraesthesia is now becoming increasingly common.\(^1\)\(^2\)

To preclude the occurrence or to diminish the progression of MSI, self-recognition, and identification by the dentists in relation to their own postures, practicing position, equipment usage pattern is the first critical step. Such recognition will aid in avoiding or neutralizing these risk factors, declining the possibility of needless reduction of professional career in clinical practice.\(^1\)\(^3\)

The current cross-sectional questionnaire study was the first formal assessment of interns and PG dental student’s knowledge regarding EE and has uncovered interesting and unseen areas of this vast and dynamic field. This particular student population was selected considering their representation of the student community treating patients with good knowledge of the subject, as they
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have already passed undergraduate level university exams prior and are destined to design the future of dentistry. Among the respondents, 69% were female, conforming to the inclination of increased feminization of dental profession. The use of gloves of proper size and fit, and its influence on hand discomfort has yet to be explored, and gloves have been cited indirectly as an impending consequence leading to carpal tunnel syndrome. In this study, when queried about equipment requiring ergonomic considerations, unexpectedly, only few respondents (<6%) thought gloves needed ergonomic designs. This suggested an unsure response of the dental professionals in this regard.

The dental chair is one of the most fundamental of all equipment in delivering optimal dental treatment. Haddad et al. recommended introduction of ergonomically designed chairs early in student training before the development of wrong postures. This study gives an insight in this regard, as only 57.84% PGs were aware that the chair height must be adjusted so that patient’s mouth should be at operator’s elbow level. Furthermore, about 62% interns mentioned that they have “No idea” regarding this. To perpetuate the neutral position, the distance between operator’s eye level and patient’s mouth should be approximately 12–16 inches. When questioned about the same, 47.06% PGs and 66.67% interns expressed that they have no idea regarding this critical chair adjustment relating to their symptoms due to awkward posture adapted during working hours.

Conceivably, the most complex and misunderstood equipment is operator’s stool. Dentists who sit for more than 80–100% of the day in a chair coupled with poor lumbar support and inadequate adjustability has more risk of developing lower back pain. In our study, 32.35% of PGs and 52.55% of interns admitted that they are not aware of the desired positioning of operator’s knees to hips during stool adjustment.

Gerwatowski et al. emphasized that keeping the working edges sharp is key to decreasing stress. The respondents in our study exhibited satisfactory and impressive knowledge regarding hand instruments ergonomics and about 93.5% were aware that sharpness and angulation of instruments are important for accessibility.

Martin et al. in 2004 stated that the lighting and surgical magnification systems are powerful allies in maintaining proper ergonomic position of the operator with reduced stress. To reduce eye-strain, it should be so adjusted that its intensity is slightly higher than that of the overhead operating light. However, surprisingly in this study, overall 76% PGs and 92.94% interns gave incorrect response, demonstrating lack of awareness regarding the same.
Taking frequent and brief rest periods in-between the working hours to prevent or to reduce MSI and to improve work productivity is known as microbreaks. A study by Galinsky et al., examined the effect of supplementary breaks among data-entry operators and concluded that it had positive effects on musculoskeletal comfort. In general, microbreaks are recommended for the dentists during dental procedures. Diaz-Caballero et al. recommended initiating occupational health programs early in dental student’s education, since our profession is more prone for MSI. However, in our study, 58.82% PGs and 79.61% interns expressed that they have never used these microbreaks intentionally themselves during the clinical work. Thus, the importance of microbreaks and exercises in the clinical practice should be stressed upon and practiced prudently.

In the current cross-sectional study, the participants lacked a proper understanding of EE and the newer advances in the conventional instruments. Since the vital aspect of EE has not been included as a part of dental curriculum in India, initiatives through lectures and seminars directly or indirectly, which includes basics, an organization of curative and diagnostic process, dental team and auxiliary personnel, professional risks and prevention programs can be undertaken. Within the limitations of this study, we suggest improvising the scenario of an acquaintance of EE in the dental curriculum.

Dental students are being introduced to the general theory of EE in the various specialties of dentistry in a stepwise manner in the practical clinical years and about 83% of the PGs and 90% of the interns were of the opinion that it should be included in the dental curriculum as a separate discipline before the student enters the clinical practice. Budding dental professionals in India are trained to excel theoretically; however, there seems to be disconnect between what is learned and what is applied in the clinics.

The advancements in the EE in the last few decades are exponential. Numerous diverse technologies are being incorporated at a breakneck speed in all aspects of dentistry giving us an added leverage in providing better and safe treatment. Thus, a consensus on a structured approach in understanding the dynamics of dental EE should be arrived upon and made available for the dental community in a more systematic manner. Furthermore, regular updates of such improvements in basic and advanced EE should be made available via additional courses for the dental students to keep them abreast and appropriate usage of the same.

We are frequently ignorant of the habits that cause us stress and this impedes with our ability to respond positively to such stimuli in our daily lives. This fundamental problem could be addressed effectively by means such as self-awareness programs (Feldenkrais method and Alexander technique), behavioral shaping (relaxation and cognitive training), exercise therapy (proprioceptive neuromuscular facilitation, aerobic exercises, and Bruegger’s exercises), and interventional strategies such as kinesio taping. Alexander technique has been recognized as a unique method of mind-body re-education and recovers postural coordination by means of conscious developments. Karatas et al. demonstrated that kinesio tape was effective in treating MSI and improving functional performance among surgeons. Systematic knowledge and clinical application of EE, in unification with practice of exercises and awareness programs with their dynamic malleability, supports the hypothesis that it is possible to reduce MSI by restraining muscle spasm, strengthening postural muscles, refining coordination, improving flexibility, and decompressing the spine.

As this study was limited to the dental Interns and PGs of Davangere, Karnataka, India, additional longitudinal studies need to be carried out to appraise the knowledge of the dental student community altogether.

The lack of inculcating the EE in the study curriculum in India necessitates that the dental faculty to make prudent efforts in creating awareness of the importance of dental EE principles. The attainment of this cognizance can be obtained at any time however early assimilation of knowledge and internalization of dental ergonomic principles might prevent their suffering from work related MSI. This study highlights upon the challenges and difficulties enduring in completing the decades-long paradigm shift to prevention and the important role to be played by the dental education community in this process. Altering the existing attitude of the faculty, students, and the dental professionals toward EE is crucial in this rewarding transformation.

Few recommendations made by the authors include:
1. Training of dental students and professionals in the critical practices of EE and evaluation of their performance and progress periodically
2. Formulation of EE interpolations (chair reformatting, magnification and lighting, activity microbreaks, structural changes with health advancing activities) and evaluating the outcomes of the students academically can help ensuring their practicing EE prudently
3. Conducting CDE programs on EE for the clinicians to emphasize upon its cruciality on practicing it and also periodic screening for MSIs-related symptoms to have interventions to prevent, diagnose early, and manage promptly
4. Generating resources and guidelines for the development and availability of EE friendly dental products and raising grants to promote this vital field
5. Setting up a nationalized monitoring agency to prevent the manufacturing, sale, and circulation of nonergonomic dental equipment
6. A detailed evidence-based research in the field of EE will promote the quality of the work offered by the dental professionals

7. Following an interdisciplinary approach by obtaining collaborations of health care professionals (dentistry, medicine, physiotherapy, etc.) and collective effort of personals from various disciplines (biomechanics, instrument designing, and manufacturing industries,) can reduce the prevalence of MSIs to a drastic noteworthy extent

8. Overcoming the resources limited Indian scenario by integrating technology in the dental office can help in upbring of the efficacy and efficiency of dental practice coupled with the co-operation obtained from dental industry, academia, and practicing dental community.

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