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Research article

A Novel assessment tool monitoring the level of patient anxiety during third molar surgery procedure

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ABSTRACT

The authors hypothesized that an audio-visual presentation providing information regarding the removal of an impacted mandibular third molar would reduce patient anxiety.

Aim& objectives: A clinical trial was performed to assess the level of patient anxiety during third molar surgery by using a new induction program and comparing the results amongst two groups that were the verbally informed and the audio-visual informed groups.

Materials and methods: the clinical trial included the patients who required surgical removal of an impacted third molar and fulfilled the predetermined criteria. The patients were divided into two groups - group 1 (no. = 20) the audio visual informed group and group 2(no. = 20) the verbally informed group. For both the groups the HR was recorded beat by beat using HR sensor (polar H1 UK) connected to an ActiGraph WGT3X- 3T USA. Also the modified dental analogue scale(MDAS) was used to subjectively record the anxiety during the surgery.

Results: The HR reading were statistically significant for the following surgical stages; drilling, suturing and upon leaving the clinic. The audio-visual informed group had lower self-reported anxiety scores than did the verbally informed group.

Conclusion: These results suggested that providing an audio-visual presentation about the surgical procedures in our routine clinical practice could aid in alleviating anxiety which would thereby reduce surgical complications.

1. Introduction

The essential nature of a patient-doctor relationship can be emphasized through patients' enlightenment on the necessary steps to be taken during an oral surgery. This enlightenment is done, prior to the actual procedure. As a way of addressing certain discrepancies and malpractices observed on the part of medical professionals through the years, it became necessary to keep patients informed of the entire process prior to medical procedures, as well as obtain patients consent, which in totality reflect involving the patients in their own medical care [1]. Also, instances and documentary evidence point to the fact that patients' anxiety may be reduced after being dealt with thorough preoperative information [1]. Furthermore, it has been shown that anxiety is related to the perception and tolerance of pain. Therefore, a patient's anxiety may impair how well the practitioner performs delicate and complex treatment procedures. It is well known that dentists consider treatment to be technically superior when patients experience less stress [2]·

Anxiety can increase surgical risk to patients, particularly in those with undiagnosed conditions for example subclinical heart ischaemia [3, 4]. Clinically, during simple dental procedures, such as low complexity restorative treatment, anticipating pain can increase anxiety and create a stressful situation with possible cardiovascular alterations [5]. Heart rat variability has been shown it gets elevated among people reporting anxiety and perceived stress [6]. Monitoring heart rate beat-by-beat, which is regulated by the sympathetic and parasympathetic nervous system, is a non-invasive method that is easy to perform in clinical practice [7, 8, 9].

Nonetheless, the process of explaining detailed procedures and their complications is associated with certain problems. Occasionally, conveying complex medical information can be difficult [10, 11] and can adversely affect patients [12]. Specifically, it has been shown that patients were often become more anxious when point by point information were revealed before surgical removal of impacted third molars [13]. The details for surgical removal of impacted mandibular third molars usually

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contain information about undesirable outcomes, such as temporary or permanent sensory nerve damage, dry socket, infection, haemorrhage, trismus, fracture of the mandible, iatrogenic damage to the adjacent second molar, and pain. Disclosing such information to patients before surgery could be stressful and elevate anxiety levels [14]. Thus, implementation of audio-visual aids to standardize the information about surgery as proposed in the literature was advised. It has been documented that audio visual presentation prompts high patient fulfilment given the feasibility, convenience, and accessibility of data [1]. There is no convincing evidence showing a decrease in preoperative anxiety. In contrast, it has been found that educating patients about the treatment with video can enhance patient knowledge about postoperative consequences and help in easing anxiety after the surgical removal of an impacted mandibular third molar [1].

The aim of the present study was to evaluate whether the conventional (verbal) method of explaining details of surgery or the audio-visual presentation could affect the anxiety level of patients who were scheduled for extraction of impacted mandibular third molars at our institute.

2. Materials & methods

All patients (no = 257) who were referred to the Oral and Maxillofacial Clinic of the dental faculty (female Campus) at King Saud University, from 15 March 2017 to 30 June 2018, for the removal of impacted third molars were considered if they fulfil the inclusion criteria of the study. The inclusion criteria were the need for surgical extraction of third molar teeth who were classified as level A or B(depth) or I & II (Ramus relation according to Pell & Gregory classification, negative medical history, no current medication use, and age 20–45 years. Surgical removal of an impacted third molar was performed under local anaesthesia. A clinical trial was planned; the study was independently reviewed and approved by the Dental Faculty Ethical Review Board (DERB) at King Saud University and complied with the rules related to the 'Research Ethics on Living Organisms' issued by Royal Decree no. M/29 and with the World Medical Association's Declaration of Helsinki. Patients were provided verbal consent; this protocol was advised and approved by the DERB. The consent form was prepared in accordance with the Research Ethics Review Committee of the World Health Organization.

A total of 40 patients scheduled to undergo extraction of impacted mandibular third molars were enrolled in this study. The patients consented to participate in the study and were blinded to the study objectives. Two patients refused to see the video prior to surgery as they claimed it would make them more anxious throughout the surgery. Immediately they were offered the treatment using verbal method. Each patient provided his or her sociodemographic information (gender, age, educational level, income, and Body Mass Index (BMI)). Four age groups were created including under 20 years, 20–29 years, 30–39 years and above 40 years. Sample size calculation was follow well established protocol (Kadam P, Bhalerao S, 2010) [15]. Sample size calculation was based on the following equation (Kadam & Bhalerao, 2010)

$$n = 2(Za + Z1{-}\beta)2\sigma2\Delta2$$

Where n is the required sample size, Za is considered accepted error for one-sided effect, which equal to 5% at 1.65. $Z_{1-\beta}$ is constant by convention according to power of study at 80% for value of 0.84. Δ is the significant change in heart rate of 10 bpm, with a standard deviation of the paired difference of 10.7 (based on standard deviation of 12 bpm and a correlation between the paired observations of $r = 0.6$) this value was estimated from previously published paper (Hollander. M et al, 2010) [16]. After adding 10% for the possibility of non-parametric testing, sample size estimated to be 22.5 participants.

Patients were asked to indicate their educational level as intermediate, secondary or college/university. With regards to income, the participants were asked to choose their approximate monthly income from four different groups as stated: less than SR 5000, SR 5000-SR 10000, SR10, 000-SR 15000 and above SR 20000. The weight and height for each patient were recorded to calculate their BMI, and patients were accordingly categorized as underweight, normal weight, overweight, or obese.

The patients were designed at parallel group, with 1.2:1 allocation ratio based on their hospital file numbers. Files Number started with Even digit, they were subjected to verbal information about the stages of surgery and the anticipated postoperative complications (group1 = 22 participants) and file number started with odd digit, the patients received audio-visual information about the same topics (group2 = 18 participants) as shown-in Fig. 1. These process of patient allocation was carried out by chief nurse who was blinded about the study objectives. A narrated video showed simple cartoon animated illustrations, created with Corel Video Studio Pro X9 by a graduated dental student at King Saud University. Audio and visual cues were included to describe the surgical procedure and postoperative complications, and a clear explanation was provided in a non-technical language. The student narrated video showed patient visited dental clinic complaining from lower third molar, this was followed by the procedure of giving local anaesthesia in the form of inferior alveolar nerve block. Then surgical incision was made through the mucosa covering the impacted lower third molar, reflection of the soft tissue using periosteal elevator was followed. The exposed bone was drilled around, and sectioning of the tooth into two halves were illustrated. Finally, tooth was removed using tooth elevator, then the wound was sutured. The common post-operative care was demonstrated like avoid eating at the side of surgery, avoid hot drinks, rest and avoid mouth gargle. Additionally, the frequent complications which may encountered third molar removal were illustrated, like swelling, trismus, pain or bleeding.

Both the verbal and the audio-visual information were similar. All questions from the patients in both groups were answered by the surgeons. To minimise possible confounding effects, such as differences in background training, two surgeons treated all patients with standardized surgical procedures. The surgeons were trained in the content and proper delivery of the information to the patients which were scripted so that each patient received the same information. The surgical field was anesthetized by mucosal infiltration and by blocking the inferior alveolar nerve and lingual nerves. In all cases local anaesthesia consisted of 40mg articaine hydrochloride with 0.01 mg epinephrine. Each carpule contained 1.7 ml injectable fluid and no more than 3 carpules were initially used for each patient. After local anaesthesia, the time-out protocol was followed, consisting of the verification of the patients' identity and the aim of the procedure. After checking the anaesthetic state of the mucosa, the surgeon made an incision and created a mucoperiosteal flap. The need for bone removal with a drill could be established at this point. When sufficient surgical access was obtained, the need for sectioning of a molar could be determined. The third molar was then removed and bone file was used to smooth any sharp or rough edges of bone, if necessary. Subsequently, the surgical wound was cleaned and subjected to curettage. The flap was repositioned, and the wound was finally sutured. If the patient complained of pain or discomfort during the procedure, a limited volume of additional anaesthetic solution was administered, and the procedure was delayed until patients' discomfort subsided. Post-surgery, routine postoperative instructions, such as use of prescribed medications, were provided to the patient. Additionally, all patients received a brochure which contained perioperative and postoperative information regarding third molar removal. Participants were told that after the surgical procedure they were expected in the consulting room again to remove the heart rate monitor and finish the contact properly. Analgesics in form of non-steroidal ant inflammatory medication NSAD e.g. Ibuprofen was prescribed, 400 mg 8 hourly for 3 days, antibiotics was not routinely prescribed. None of the operated cases reported any remarkable complications which might require further managements.

2.1. Modified Dental Anxiety Scale (MDAS)

Patients were asked to rate their anxiety level based on a Modified Dental Anxiety Scale [17]. The scale was used only when the patient was seated on the dental chair and ready for surgery. This scale was chosen because it is reliable and considers anxiety during local anaesthesia injection rather than the Corah MDAS [18].

The patients were asked to score their anxiety levels through various situations on a scale from 0 (no anxiety at all) to 5 (maximum anxiety). The patients were asked to complete the scale at the following 8 different time points: immediately once the patient was seated on dental chair, after giving instructions, after injection, before extraction, during drilling, after extraction, during suturing, and before leaving the clinic.

2.2. Heart rate (HR) recording

A HR sensor (*POLAR* H10, UK) detects beat-by-beat HR patterns, and a chest built recording strip. The sensor was placed directly on the skin of the subject (directly on the apex beat), and the *POLAR H10* was found to be compatible with many Bluetooth devices. The sensor connects the HR to any application aiming to optimize the training or the workout of an individual. In our study, we connected it with and ActiGraph wGT3X-BT (USA) medical-grade wearable activity monitoring system, which has been deployed in many pharmaceutical drug trials around the world to capture high quality physical activity and sleep data. The activity monitors are FDA 510(k) approved Class II medical devices in the U.S. and adhere to regulatory standards worldwide. The other interesting feature of the *POLAR H10* is its high precision due to improved electrodes that made Polar the most accurate heart rate sensor.

USB ANT sticks wirelessly send recorded HR data to the computer during surgery. ActiGraph premiere data analysis software were used. ActiLife's robust screening and analysis toolkit allows users to process and score collected data using a comprehensive selection of independently developed and validated algorithms. However, in this study, we limited the functionality of ActiLife's to HR monitors per seconds only.

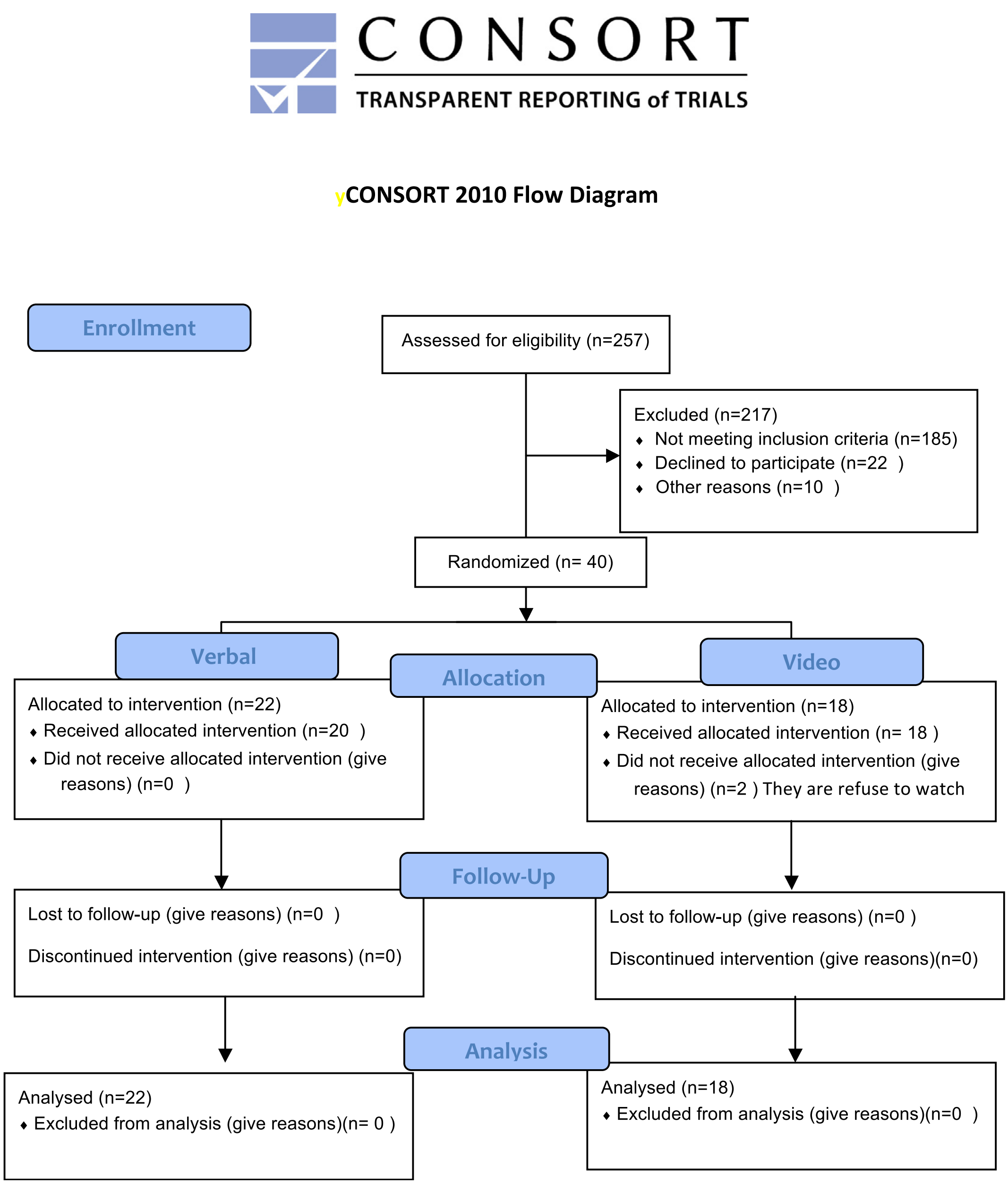

Fig. 1. CONSORT flow chart, shows the participnat the flow through the trial according to the criteria recommended in the CONSORT Guidelines. https://doi.org/10.1371/journal.pone.0019857.g001 The chart is downloaded April/2019.

2.3. Data collection from ActiLife software

A data table containing separate columns with corresponding headers for each data type collected by the device from each patient was generated. The author chose to use a single axis for Vector Magnitude. A standard *.csv file produced during conversion simply exported the data into *.csv format. Data were exported as native *.AGD files to *.MAT format for easy importing into MathWorks MATLAB® mathematical software platform.

Another important point to consider was that the "Re-Integrate AGD File" option allows users to integrate AGD files to larger epoch periods (e.g., 1 s epoch data collection reintegrated to 60 s epoch periods). We chose to use 3 s, which means that the HR was integrated every 3 s. The data were then exported to any format directly from the AGD file viewer by clicking on "Export data". Data were exported to SPSS for statistical analysis.

2.4. Statistics

The results were analysed using parametric tests to determine whether there were statistically significant differences between the groups for the categorical variables. To compare the continuous variables (i.e., anxiety and physiological measures) between the groups across the 8 stages of data collection, we used mixed models for repeated measures (SPSS program) following an exploratory analysis and a selection of the best covariance structure. When the difference was significant, multiple comparison tests and Student's t-test were used to identify differences between the averages (p-value <0.05).

3. Results

All participants met the above prescribed inclusion criteria and were assigned either to watch the video presentation or listen to routine verbal explanation of procedures and the possible postoperative complications. Our data showed a constant increase in participant HR during different phases of surgical procedures, namely, during injection, extraction, immediately after tooth removal, during suturing and upon leaving the clinic, data are shown in Table 1.

Table 1
Data illustrate the HR reading and MDAS scoring for different tested group, also the recorded HR for the demographic variables.

Parameters	Group1(Audio-Visual)		Group 2(verbal)		
HR reading	initialize	90	92		
	instruction	88	98		
	injection	96	102		
	Before exo	96	104		
	During exo	99	103		
	After exo	92	103		
	Suturing	91	108		
	Leaving	93	113		
Median MDAS	initialize	3	1.5		
	instruction	2	2		
	injection	2	2		
	Before exo	3	2		
	During exo	4	3		
	After exo	2	2		
	Suturing	2	1		
	Leaving	2	1		
Level of Education	Intermediate		Secondary	Collage	
	initialize	102	98	88	
	instruction	97	108	88	
	injection	121	106	96	
	Before exo	106	104	99	
	During exo	98	100	101	
	After exo	96	106	95	
	Suturing	100	110	96	
	leaving	124	111	100	
Income level in SR	Less than 5000		5000–10000	10000–15000	Above 20000
	initialize	96	92	84	91
	instruction	94	97	90	85
	injection	94	103	96	93
	Before exo	94	104	93	97
	During exo	93	104	93	100
	After exo	84	104	92	89
	Suturing	116	102	91	93
	leaving	122	103	94	102
BMI HR RESADING	Under weight		Normal	Over weight	obese
	initialize	100	89	93	83
	instruction	103	85	99	97
	injection	109	89	103	115
	Before exo	108	88	104	126
	During exo	107	89	105	126
	After exo	97	82	108	129
	Suturing	95	89	104	129
	leaving	100	95	106	129

The highest reported mean for HR was 103.5 ± 27 bpm before leaving the clinic while the highest for MDAS was 3.4 ± 1.4 during drilling. The Median MDAS before drilling and immediately after extraction were 2.7 ± 1.4 and 2.7 ± 1, respectively.

When comparing HR for the two groups (verbal(N = 22) vs. video(N = 18)), it was found that those who watched the video before surgery had lower HR reading compared with those who received verbal instructions. These differences in mean HR reading were statistically significant for the following surgical stages: during drilling, suturing, and upon leaving the clinic (Tables 2 and 3). On the contrary, MDAS was found to be inversely proportionate to HR records. Patients who were subjected to the video reported higher anxiety scores throughout some surgical stages namely (initialization, before and during tooth removal, suturing and leaving the clinic) compared with the other group. However, these differences were not statistically significant. Similar finding was reported by Netherland's study 2016 in which they had reported a non-linear relationship. This finding may indicate what patients may subjectively express not reflecting their body physiological response due to the effect of different variables (like, surgeon, difficulty of surgery).

When we looked at the demographic variables, we found a relationship among the recorded HR, income, BMI, and level of education. We found a significant difference in MDAS score level in relation to different independent groups based on their income. The highest scores were reported for the income group above SR 20,000 and SR10,000–15,000 at 4.3 ± 0.3 and 4.1 ± 0.5 during the drilling stage, respectively. On the other hand, the Income group of less than 5000 per month showed the highest HR reading during suturing and upon leaving the clinic with 116 ± 30 and 122 ± 24 successively (Table 4). Nonetheless, in both assessments there were no reported significance differences between the groups.

With regards to the level of education, participants who had an intermediate education had higher initial HR recordings, at injection, before extraction and upon leaving when compared with participants who had college education. However, these differences were not statistically significant among the groups (Table.5). In contrast, participants who finished their college education had higher MDAS at the following stages: initially, before extraction, during drilling, after extraction and during suturing. These data revealed statistically significant differences in Median scores between the groups.

In addition, the BMI variable was appraised. The obese group who had BMI values > 30 had the highest HR recordings. The differences in means were statistically significant from injection until leaving the clinic at $p < 0.05$. Overweight and underweight patients had an MDAS score of 4 ± 1.4 at injection and drilling phases, and this value was statistically significantly different at p value < 0.05(Table 6). Finally, the correlation between HR and MDAS was investigated. The data demonstrated a positive correlation within all surgical phases except at suturing at < 0.05 level (Fig. 2).

Table 2
Data illustrate the HR reading for the tested groups recorded during different surgical stages, mean, Std deviation in top table, next table is shown statistical Pearson correlations at different surgical Stages and the *p-values,* all N = 40.

Surgery Stages	Means	STD.DEV	N
Initialize	91.0268	17.32370	40
Instruction	93.3613	18.11262	40
INJECTION	99.3728	18.63095	40
Before_Extraction	100.370	21.1032	40
During	101.2653	19.97628	40
After_Extraction	97.7738	23.70843	40
Suture	99.5825	25.87987	40
Leaving	103.5768	27.65011	40

Surgery Stages	Initialize	Instruction	Injection	Before Extraction	During	After Extraction	Suture	leaving
Initialize Pearson Correlation	1	.556**	.521**	.355*	.314*	.162	.131	-.034
Sig. (2-tailed)		.000	.001	.025	.049	.318	.421	.837
Instruction Pearson Correlation	.556**	1	.722**	.569**	.508**	.543**	.445**	.318*
Sig. (2-tailed)	.000		.000	.000	.001	.000	.004	045
Injection Pearson Correlation	.521**	.722**	1	.842**	.792**	.669**	.606**	.482**
Sig. (2-tailed)	.001	.000		.000	.000	.000	.000	.002
Before Extraction Pearson Correlation	.355*	.569**	.842**	1	.929**	.722**	.750**	.614**
Sig. (2-tailed)	.025	.000	.000		.000	.000	.000	.000
During Pearson Correlation	.314*	.508**	.792**	.929**	1	.815**	.723**	.584**
Sig. (2-tailed)	.049	.001	.000	.000		.000	.000	.000
After Extraction Pearson Correlation	.162	.543**	.669**	.722**	.815**	1	.696**	.584**
Sig. (2-tailed)	.318	.000	.000	.000	.000		.000	.000
Suture Pearson Correlation	-.034	.318*	.482**	.614**	.584**	.584**	.917**	1
Sig. (2-tailed)	.837	.045	.002	.000	.000	.000	.000	
Leaving Pearson Correlation	-.034	.318*	.482**	.614**	.584**	.584**	.917**	1
Sig.(2tailed	.837	.045	.002	.000	.000	.000	.000	

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

4. Discussion

The present study sought to determine whether the use of an audio-visual presentation of surgical information would lessen anxiety during the removal of an impacted mandibular third molar in our speciality clinic at Dental faculty, KSU. Data were compared with a group who received verbal information as a typical daily practice in our surgical unit.The novelty of this study is the recording of heart rate per second using *POLAR* H1 sensor ActiGraph wGT3X-BT HR monitor and using the MDAS throughout the surgical phases aiming to assess the effect of audio-visual video on level of anxiety.

The MDAS was chosen because it is reliable, sensitive and easy to use in a clinical setting. The data showed lower HR readings for group who had been instructed with an audio-visual presentation compared with those who received verbal instructions. These differences in mean HR recording were statistically significant during most of the surgical phases. The data showed an increase in Median MDAS scores for those who were subjected to audio-visual slide information, with no statistically significant difference. A similar study design was conducted by Choi S et al., 2015 [1], however they assessed DAS after one week from the day of surgery. Thus, they reported statistically significant differences between the groups. These finding may infer that the audio-visual presentation viewed before surgery improved the understanding of potential post-operative complications. Additionality, a balanced amount of information was usually delivered in the video with a calming tone of voice, which are paramount factors as it has been found that overdetailed listing and disclosure before extraction of impacted mandibular third molars can exaggerate patient stress [12]. Heart and pulse rates have been used extensively in the literature as parameters for recording the autonomic system response to stress and level of anxiousness in other studies [18, 19, 20]. In this study, HR was monitored during different surgical stages and reported every 3 s. Although the use of HR assessment during the procedure itself is questionable as HR can be affected by numerous other factors such as, pain, pressure and amount of local anaesthesia. Thus, the authors consider using MDAS as another reliable subjective assessment tool. Similarly, Thyer B et al, 1984 showed significant correlation between two autonomic physiologic (HR& Peripheral vasoconstriction) indices and anxiety scale [21].

Concerning the demographic data, level of education and BMI significantly affected patient anxiety during drilling. Increased mean HR was observed in patients who had an intermediate level of education. This could be due to difficulty in understanding the surgical procedure, possible complications, or too many details about the surgery, which the patients might not understand and would therefore make them more anxious.

For BMI, obese candidates had the greatest HR recordings, which could be partly due to physiological adaptation of their body systems. It is a well-known fact that increased blood pressure and HR values are noted in obese people, presented by a decrease in parasympathetic activity and prevalence of sympathetic activity [22]. The BMI was considered in our study as it is remains the most commonly used, widely accepted, and practical measure of obesity in both children and adults [23].

BMI is strongly correlated with gold standard body fat measures, although it cannot distinguish between lean and fat mass and provides no indication of body fat distribution. Compared with direct measures e.g "dual energy x ray absorptiometry (DEXA) and imaging techniques". However it has been shown BMI has high specificity (0.90) but low sensitivity (0.50) for assessing obesity (Okorodudu et al, 2010) [24].

Table 3
Data illustrate the HR reading and AS scoring for different tested groups(verbal and video), Mean & std deviation, this followed by statistical analysis T-Test between the Meaden readings and their p-values.

Surgical stages for MDS, AND HR reading	Instructions	N	Mean	Std. Deviation	Levene's Test for Equality of Variances		Sig. (2-tailed)	Mean Difference
					f	sig		
Initialize_MEAN	Verbal	20	92.0230	16.84417	.018	.89	.721	1.99250
	video	20	90.0305	18.17144			.721	1.99250
Initialize_AS	verbal	20	2.40	1.635	.278	.60	.842	-.100
	video	20	2.50	1.504			.842	-.100
Instruction_MEAN	verbal	20	98.6505	21.95915	4.543	.04	.064	10.57850
	video	20	88.0720	11.50214			.066	10.57850
Instruction_AS	verbal	20	2.50	1.638	2.056	.16	.834	-.100
	video	20	2.60	1.353			.834	-.100
Injection_MEAN	verbal	20	102.5260	23.83297	12.906	.00	.290	6.30650
	video	20	96.2195	11.11532			.293	6.30650
Injection_AS	verbal	20	2.30	1.342	.019	.89	.243	-.500
	video	20	2.80	1.322			.243	-.500
Before_Extraction_MEAN	verbal	20	104.035	25.6322	6.161	.01	.278	7.3300
	video	20	96.705	15.1275			.279	7.3300
Before_Extraction_AS	verbal	20	2.55	1.395	.014	.90	.441	-.350
	video	20	2.90	1.447			.441	-.350
During_MEAN	verbal	20	103.2445	24.95571	9.979	.00	.538	3.95850
	video	20	99.2860	13.71393			.539	3.95850
During_AS	verbal	20	3.00	1.451	.212	.64	.059	-.850
	video	20	3.85	1.309			.059	-.850
After_Extraction_MEAN	verbal	20	103.1375	29.27155	5.989	.01	.155	10.72750
	video	20	92.4100	15.37435			.158	10.72750
After_Extraction_AS	verbal	20	2.45	1.468	.121	.72	.375	-.400
	video	20	2.85	1.348			.375	-.400
Suture_MEAN	verbal	20	108.0370	30.51080	4.517	.04	.037	16.90900
	video	20	91.1280	17.12880			.039	16.90900
Suture_AS	verbal	20	1.90	1.165	.108	.74	.348	-.350
	video	20	2.25	1.164			.348	-.350
Leaving_MEAN	verbal	20	113.3815	30.70786	4.381	.04	.023	19.60950
	video	20	93.7720	20.58973			.024	19.60950
Leaving_AS	video	20	1.70	1.081	.960	.33	.875	-.050
	verbal	20						

Table 4
Data illustrate the HR reading in relation to the level of income for all tested groups, also shows the one way ANOVA test for HR in relation to income, and its P-value.

Surgical stages	Income	N	Mean	Std. Deviation	ANOVA	Sum of Squares	Mean Square	F	Sig
Initialize_HR	less 5000	3	96.0000	18.33030	Between Groups	346.5	115.5	.366	.778
	5000–10000	22	92.0650	16.78146					
	10000–15000	6	84.5900	14.25335	Within Groups	11357.7	315.4		
	above 20000	9	91.1222	21.66788					
Instruction_HR	less 5000	3	94.4000	13.22422	Between Groups	1014.6	338.2	1.034	.389
	5000–10000	22	97.4095	21.21533					
	10000–15000	6	90.1217	7.08051	Within Groups	11779.9	327.2		
	above 20000	9	85.2789	14.69529					
Injection_HR	less 5000	3	94.1000	14.06521	Between Groups	834.2	278.09	. 788	.508
	5000–10000	22	103.4409	21.68825					
	10000–15000	6	96.0367	14.84526	Within Groups	12703.1	352.8		
	above 20000	9	93.4100	12.88194					
Before_Extraction_HR	less 5000	3	94.133	25.4451	Between Groups	738.5	246.1	.533	.663
	5000–10000	22	104.055	23.5538					
	10000–15000	6	93.683	9.6996	Within Groups	16629.8	461.9		
	above 20000	9	97.900	20.0441					
During-HR	less 5000	3	93.0000	25.11971	Between Groups	888.2	296.07	.726	.543
	5000–10000	22	104.9368	22.68980					
	10000–15000	6	93.3167	8.15951	Within Groups	14674.8	407.6		
	above 20000	9	100.3444	16.83947					
After extraction-HR	less 5000	3	84.8033	15.76629	Between Groups	2155.7	718.5	1.309	.287
	5000–10000	22	104.2123	28.30578					
	10000–15000	6	92.8050	8.24353	Within Groups	19765.7	549.05		
	above 20000	9	89.6711	16.21456					
Suture-HR	less 5000	3	116.6667	53.14446	Between Groups	1750.8	583.6	.862	.470
	5000–10000	22	102.0336	27.09106					
	10000–15000	6	91.8217	12.50358	Within Groups	24370.0	676.9		
	above 20000	9	93.0700	17.77377					
Leaving –HR	less 5000	3	122.8333	42.37362	Between Groups	1623.2	541.1	.691	.564
	5000–10000	22	103.8836	28.47987					
	10000–15000	6	94.4667	19.67594	Within Groups	28193.3	783.148		
	above 20000	9	102.4811	26.53631					

Table 5
Data illustrate the HR reading in relation to the level of education for all tested groups, also show the one way ANOVA test for both HR and MDAS in relation to level of education, and its P-value.

Surgical stages	Income	N	Mean	Std. Deviation	Mean Square	F	Sig
Initialize_HR	Intermediate	1	102.1100	.	115.5	.366	.778
	Secondary	9	98.7111	15.78587			
	Collage	30	88.3520	17.46115	315.4		
	Total	40	91.0268	17.32370			
Instruction_HR	Intermediate	1	97.0000	.	338.2	1.034	.389
	Secondary	9	108.6000	24.83506			
	Collage	30	88.6683	13.25669	327.2		
	Total	40	93.3613	18.11262			
Injection_HR	Intermediate	1	121.4000	.	278.09	. 788	.508
	Secondary	9	106.7422	25.55992			
	Collage	30	96.4277	15.62129	352.8		
	Total	40	99.3728	18.63095			
Before_Extraction_HR	Intermediate	1	106.000	.	246.1	.533	.663
	Secondary	9	104.056	24.3785			
	Collage	30	99.077	20.6863	461.9		
	Total	40	100.370	21.1032			
During-HR	Intermediate	1	98.3000	.	296.07	.726	.543
	Secondary	9	100.3233	23.68653			
	Collage	30	101.6467	19.52317	407.6		
	Total	40	101.2653	19.97628			
After extraction-HR	Intermediate	1	96.1300	.	718.5	1.309	.287
	Secondary	9	106.2822	34.43902			
	Collage	30	95.2760	19.99285	549.05		
	Total	40	97.7738	23.70843			
Suture-HR	Intermediate	1	100.0000	.	583.6	.862	.470
	Secondary	9	110.5144	35.62999			
	Collage	30	96.2890	22.40983	676.9		
	Total	40	99.5825	25.87987			
Leaving –HR	Intermediate	1	124.0000	.	541.1	.691	.564
	Secondary	9	111.4567	29.95984			
	Collage	30	100.5320	27.15334	783.148		
	Total	40	103.1100	27.65011			

	ANOVA	Sum of Squares	Mean Square	Sig
Initialize_MDAS	Between Groups	3.811	1.906	.46
	Within Groups	90.089	2.435	
Initialize_MDAS	Between Groups	2.533	1.267	.57
	Within Groups	83.367	2.253	
Injection_MDAS	Between Groups	2.878	1.439	.45
	Within Groups	67.022	1.811	
Before_Extraction_MDAS	Between Groups	5.275	2.638	.27
	Within Groups	72.700	1.965	
During_MDAS	Between Groups	4.575	2.288	.33
	Within Groups	75.200	2.032	
After_Extraction_MDAS	Between Groups	12.133	6.067	.04
	Within Groups	64.967	1.756	
Suture_MDAS	Between Groups	1.975	.988	.49
	Within Groups	50.800	1.373	
Leaving_MDAS	Between Groups	.953	.476	.62
		37.022	1.001	

Obese individuals reported the highest resting heart rate of young adolescent males [25]. Interestingly, in our study, MDAS scores were higher for under and overweight candidates at several phases of the surgery. The data for underweight individuals were not consistent with the noted HR, which has a close association with changes in body mass index extent. Thus, in underweight and overweight subjects, the versatile adaptability of autonomic cardiac function was lessened [26, 27].

It was interesting to note the importance of conveying optimum amount of surgical details, postoperative instructions and possible complications, which minimised patient anxiety and thereafter reduced postoperative pain. These facts have been mentioned in previous studies [28, 29]. Vallerand et al. reported that by providing good amount of information and to make sure that the patients understand about the possible outcomes, could considerably provide relief from pain and satisfaction with pain control. Thus preventing the use of increased amount of analgesics [28].

On the other hand, studies have shown that preoperative information provided in audio-visual presentations fails to minimise patient anxiety before or after third molar extraction. Kazancioglu et al claimed that watching a movie about third molar extractions led to an increase in anxiety and pain during the postoperative period [30]. Furthermore, Torres-Lagares et al. reported that information given in a video format increased patient anxiety and did not provide advantages for dental treatment [31]. Audio-visual presentation showing detailed surgical steps and information can cause apprehension and fear among patients, which in turn counterbalance the more tolerable situation provided by better understanding or enhanced knowledge [30]. In the later study, the authors used DAS, the Spielberger State-Trait Anxiety Inventory (STAI), and pain analogue scales. However, the test was performed before surgery, after surgery, and one week after surgery for pain scoring. Nevertheless, in our study, MDAS was performed throughout the phases of the surgery, and we used an objective tool to record HR beat-by-beat to monitor the autonomic system response in the body. Moreover, a simplified animation clip presentation for all surgical steps was presented. Having said that, we considered many variables like levels of education, age, finical status and BMI. Based on our results, we believed

Table 6
Data illustrate the HR reading in relation to BMI for all tested groups, also shows the one way ANOVA test for both HR& BMI values, and its P-value.

Surgical stages	BMI	N	Mean	Std. Deviation	Anova	Mean Square	Sig
Initialize_HR	Underweight	5	100.	16.0	Between Groups	292.973	.42
	Normal Weight	18	89.1	18.9			
	Overweight	12	93.3	15.3	Within Groups	292.973	
	Obesity	5	83.0	16.7			
Instruction_HR	Underweight	5	103.9	15.7	Between Groups	736.872	.07
	Normal Weight	18	85.3	10.9			
	Overweight	12	99.2	16.2	Within Groups	736.872	
	Obesity	5	97.2	34.07			
Injection_HR	Underweight	5	109.6	15.1	Between Groups	1264.093	.007
	Normal Weight	18	89.4	12.7			
	Overweight	12	103.20	16.5	Within Groups	1264.093	
	Obesity	5	115.6	27.7			
Before_Extraction_HR	Underweight	5	108.2	14.8		2204.648	.001
	Normal Weight	18	88.1	14.1	Between Groups		
	Overweight	12	104.4	17.6	Within Groups	2204.648	
	Obesity	5	126.6	27.6			
During-HR	Underweight	5	107.1	16.1		2061.909	.000
	Normal Weight	18	89.5	13.3	Between Groups		
	Overweight	12	105.6	17.8	Within Groups	2061.909	
	Obesity	5	126.9	21.4			
After extraction-HR	Underweight	5	97.8	12.64116		3603.809	.000
	Normal Weight	18	82.0	8.70403	Between Groups		
	Overweight	12	108.0	24.24098		3603.809	
	Obesity	5	129.6	12.64116	Within Groups		
Suture-HR	Underweight	5	95.4	95.4600	Between Groups	2299.863	.011
	Normal Weight	18	89.1	89.0972			
	Overweight	12	104.4	104.4583	Within Groups	2299.863	
	Obesity	5	129.7	129.7500			
Leaving –HR	Underweight	5	100.2	100.2660	Between Groups	1578.057	.098
	Normal Weight	18	95.1	95.1556			
	Overweight	12	106.9	106.9367	Within Groups	696.734	
	Obesity	5	129.1	129.1400			

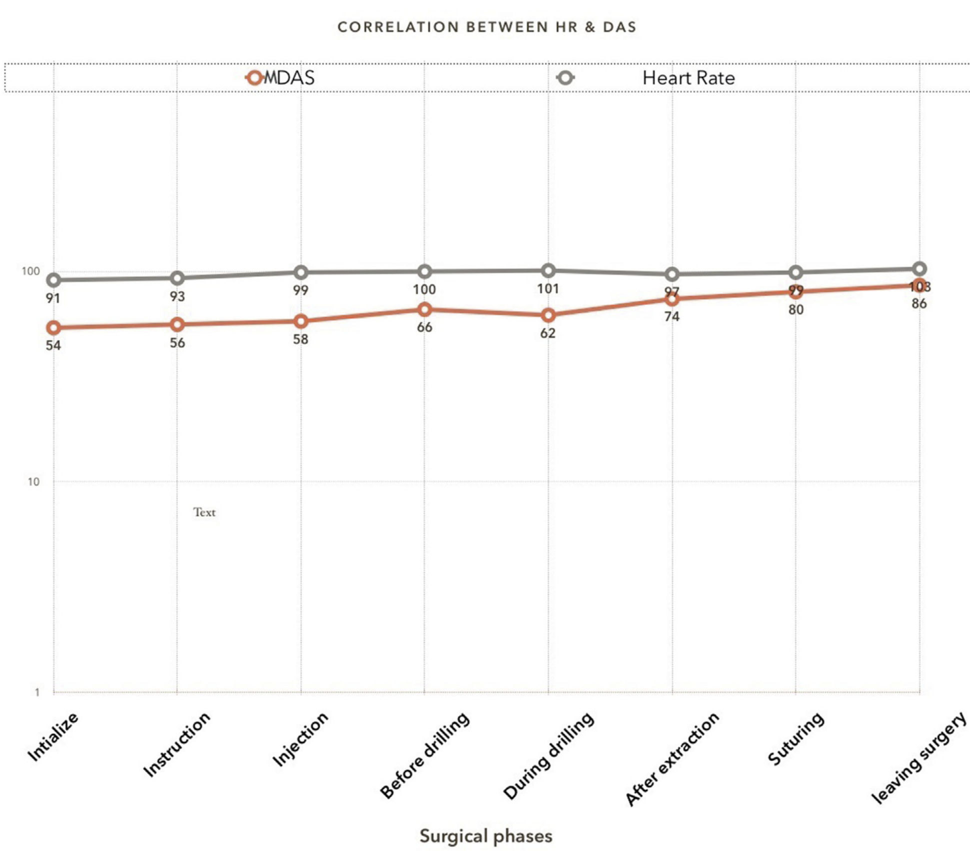

Fig. 2. The linear relationship between the reported HR and the subjective MDAS score reported during different surgical phases.

that an audio-visual presentation that provided a concise amount of information is required to control patient anxiety throughout the procedure compared with routine verbal instructions that are commonly delivered in our daily practice. Our audio-visual presentation was designed by using standardized illustrations, bullets, large font sizes, and nontechnical language to facilitate better comprehension. Unfortunately, we did not include a postoperative pain assessment strategy in this study, however, such an assessment should be considered in the future.

Controlling patient anxiety is a paramount pre-requisite to achieve optimum dental service and should be implemented in routine dental practice. Our previous work showed that 3.6% of patients who attended clinic for third molar removal developed a vasovagal attack as the main complication reported by the treating surgeons [32]. Moreover, it has been shown that surgeons require more operative time when patients were anxious [33]. It tends to be contended introducing audio visual presentation in our practice would add more burden with regard to time and cost when compared to routine verbal informed consent [34].

Nevertheless, the burden of time and cost required for audio visual presentation is negligible to what would be achieved by better understanding of the surgical procedure. Having said that an extent of claims results from an absence of communication between the surgeon and patient as opposed to malpractice [35]. Therefore, implementing such a system would provide an optimum service to the patients and minimize such a risk.

Furthermore, it has been shown that anxiety is related to the perception and tolerance of pain. The clinician's performance may be hundred by patient anxiety in spite of delivering comprehensive and optimal treatment [32]. Patients are happier and satisfied when they are provided with reasonable information before the surgical procedure, which helps them understand the situation better. Despite the fact that most patients do not recollect a great amount of the information provided to them during the process of informed consent [1].

There were short-comings in this study that should be considered when interpreting the data. First, although the present study has used population-based sample, but was limited to patients who access service at Dental Collage, King Saud University. It would have been ideal to run the study in multicentre approach for sample selection. Previous related studies had much larger sample sizes [32, 33]. A larger cohort of patients might provide sufficient statistical power to detect a correlation between HR and MDAS. Second, the gender of the current study included only women, and this was because of logistic reasons, as the study was conducted in the female campus in our institute. Gender might influence the factors analysed in this study, as young women frequently report feeling more anxious than men [17, 26,31]. There was evidence in literature showed there was interaction between a cognitive vulnerability for panic disorder, anxiety sensitivity, and the effects of progesterone and its metabolite, allopregnanolone, on behavioural and physiological responses to stress during the premenstrual phase. However, those variable were not considered because the sample was single cohort female patient who were referred for surgical extraction. Finally, a postoperative pain assessment strategy was not planned for this study and ranking surgical difficulty in relation to level of anxiety was not considered.

In conclusion, our experience at our institute with audio-visual presentations could minimize patient's anxiety during surgical removal of impacted mandibular third molar. This would be due to better understanding of the surgical procedure and its potential complications. Additional studies are needed to evaluate the knowledge and the postoperative pain scoring. Larger patient samples including males are recommended to validate the results of the present study.

Declarations

Author contribution statement

Randa Alfotawi: Conceived and designed the experiments, performed the experiments, analyzed and interpreted the data, wrote the paper.

Abdulrahman Alhowikan: Conceived and designed the experiments, contributed reagent, materials and analyzed and interpreted the data.

Alia Alfadhel: performed the experiments.

Sangeetha Premnath: performed the experiments, wrote the paper.

Jamilah Tawhari: performed the experiment, contributed reagents, materials, analysis tools or data.

Anfal Alhamid: contributed reagents, materials, analysis tools or data.

Shaima Bahammam: contributed reagents, materials, analysis tools or data.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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