Pain perception during cataract surgery

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PAIN PERCEPTION DURING CATARACT SURGERY

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1. INTRODUCTION

1.1 Basic anatomy of the eye

The five senses include vision, sound, taste, hearing and touch. Vision is by far the most used of the five senses and is one of the primary means that we use to gather information from our surroundings. The vast majority of the information we receive about the world around us is provided to us by our eyes as visual information. Vision, like the other senses is closely related to other parts of our anatomy. The eye is especially closely connected to the brain and dependent upon the brain to interpret what we see. The eye is often compared to a camera in some aspects. Each gathers and processes light in its own way and then transforms that light into a "picture". Both are well equipped to do so by using lenses to focus the incoming light. Just as a camera focuses light onto the film to create a picture, the eye focuses light onto a specialized layer of cells, called the retina, to produce an image. This chapter is going to cover the essentials of the eye anatomy.

1.1.1 The sclera

Together with the cornea the sclera forms the anterior surface of the eye. It is almost acellular fibrous tissue with high water content. The sclera is thickest at the corneal limbus (1mm) and thinnest at the equator (0.3mm). Trabecular meshwork is also a part of the sclera and it makes a part of the angle of the anterior chamber and the Schlemm’s canal, which drains the aqueous humor (1). The inner layer of the sclera, so called the lamina fusca, blends with the uveal tract. The sclera itself is avascular, but it is pierced by vessels before they reach the episclera which covers the sclera. The Episclera is well vascularized and innervated. It also supplies nutrition to the sclera (2).

1.1.2 The cornea

With 43 diopters the cornea is the most important refractive medium in the eye (1). It is a transparent structure which is thicker peripherally than centrally (2). The cornea is made up of five distinct layers as seen in Figure 1. Most anteriorly lies the epithelium, which is divided into two areas, the limbus and the central cornea. The epithelium in the central area is non-keratinized stratified squamous and around 5-7 layers thick. At the limbus there are the stem cells for production of new cells to differentiate into corneal epithelium (2). Posterior to the epithelium is the BM zone, which includes the basement membrane and the Bowman´s layer. Bowman´s layer is a strong but thin avascular layer, which cannot regenerate and heals by scarring (1). The epithelium and the BM zone are of ectodermal origin (2). Beneath that lies the stroma, which accounts for 90% of the corneal thickness and its main component is water (2).

The stroma is the first structure that is of mesenchymal origin (1). The posterior surface of the cornea is made up of the Descemet´s membrane and the corneal endothelium. Descemet´s membrane is a relatively strong membrane keeping the shape of the anterior chamber (1). It is an avascular structure of mesenchymal origin and not capable of regeneration (2). The endothelium is a monolayer of hexagonal cells. They are of mesenchymal origin and cannot regenerate, so that cell loss is compensated by polymegathism and migration of neighboring cells (1,2).

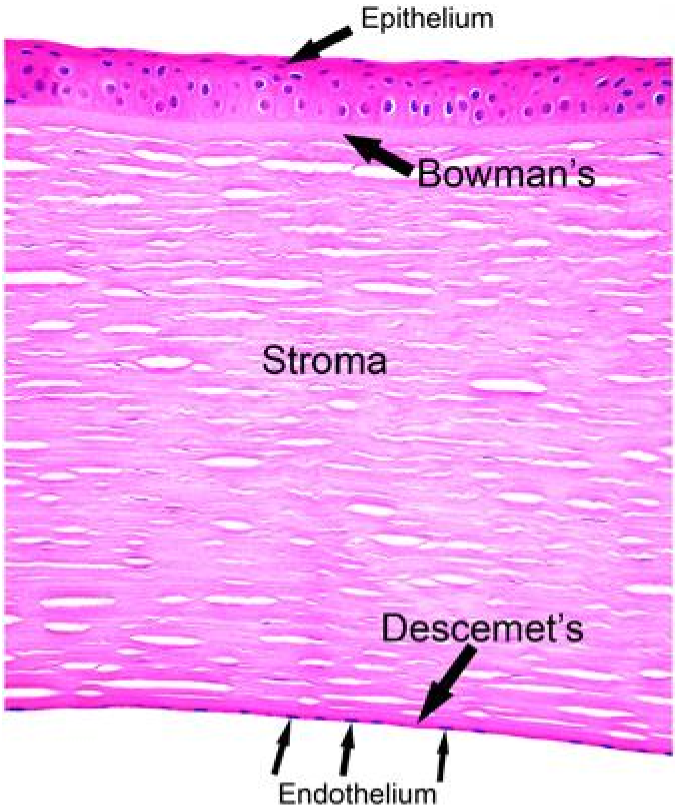

Figure 1. Anatomy of the cornea

Available at: https://www.researchgate.net/figure/H-E-showing-a-normal-cornea-The-cornea-has-five-layers-The-surface-epithelium-is_fig3_234050738

1.1.3 The uveal tract

The uveal tract consists of three parts, the iris, the ciliary body and the choroid. Most anteriorly is the iris, which is divided into the central pupillary zone and the peripheral ciliary zone by the collarette (1). The pupillary zone contains the sphincter muscle, which is under parasympathetic control. The dilator pupillae muscle is in the ciliary zone and supplied by sympathetic fibers (2). There is an anterior mesodermal stromal layer and a posterior ectodermal pigmented epithelial layer (1). Between the root of the iris and the *ora serrata* is the ciliary body, consisting of the ciliary muscle and the ciliary epithelium (1). It is anatomically separated into the anterior *pars plicata* and the posterior *pars plana* (2). The epithelium of the ciliary body is responsible for aqueous humor production and the ciliary muscle contracts to allow for accommodation and increased trabecular outflow (1,2). The choroid is a vascular layer extending from the *ora serrata* to the optic disc. From inside to outside it is composed of Bruch´s membrane, the choriocapillaris, a medium-sized vessel layer known as Sattler´s layer, a large vessel layer known as Haller´s layer and the suprachoroidal space (2). The function of the choroid is temperature regulation and nourishment of the outer layers of the retina (1,2).

1.1.4 The lens

The lens is a transparent, biconvex, avascular structure providing one third of the refractive power of the eye, which is 10-20 diopters depending on the degree of accommodation (1). The adult lens is 4-5mm thick (2). Curvature of the lens is more pronounced on the posterior side than on the anterior side (1). It is made up of an outer acellular capsule, lens epithelium, cortex and nucleus (2). The lens lies in the posterior segment of the eye in the so-called hyaloid fossa, a depression in the anterior vitreous body. It is held in place by the zonule fibers, which insert at its equator and connect the lens to the ciliary body as seen in Figure 2 (1). They also transfer the tension from the ciliary muscle onto the lens for accommodation (2). The lens is a purely ectodermal structure and in opposition to other epithelial structures it grows in a way, so that the youngest cells are always on the surface (2). First the primary lens fibers form the embryonic nucleus. Then new secondary fibers displace the primary fibers centrally and the fetal nucleus forms around the embryonic nucleus. During infant and adult life, the infantile and adult nucleus form respectively. The different nuclei become continuously compressed with time, creating density zones, because they are enclosed by the capsule. These different nuclei or zones are depicted in Figure 3 (1). Nourishment of the lens is provided by diffusion from the aqueous humor (1). Homeostasis of water content and proteins is essential for the transparency of the lens (2). It is therefore important to keep it well regulated (1). But with age the water content decreases, and the lens becomes stiff and transparency is decreased (1,2).

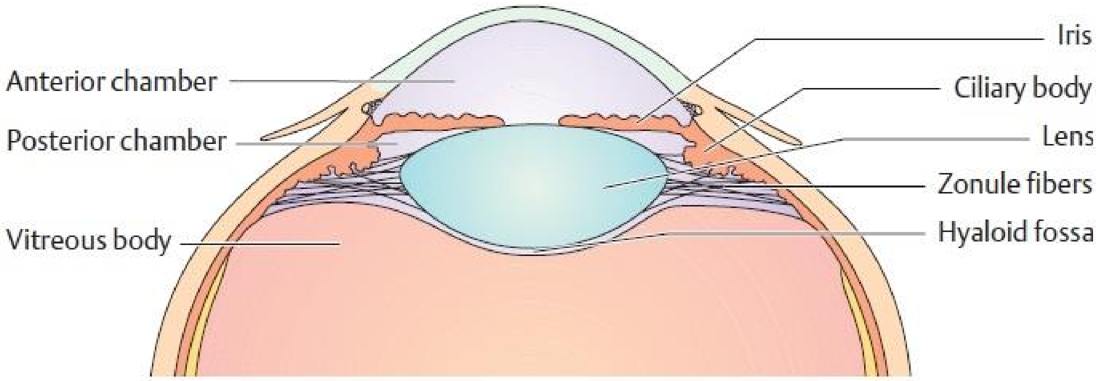

Figure 2. Shape of the lens and its position in the eye taken from Lang G. Ophthalmology. Stuttgart: Thieme; 2007

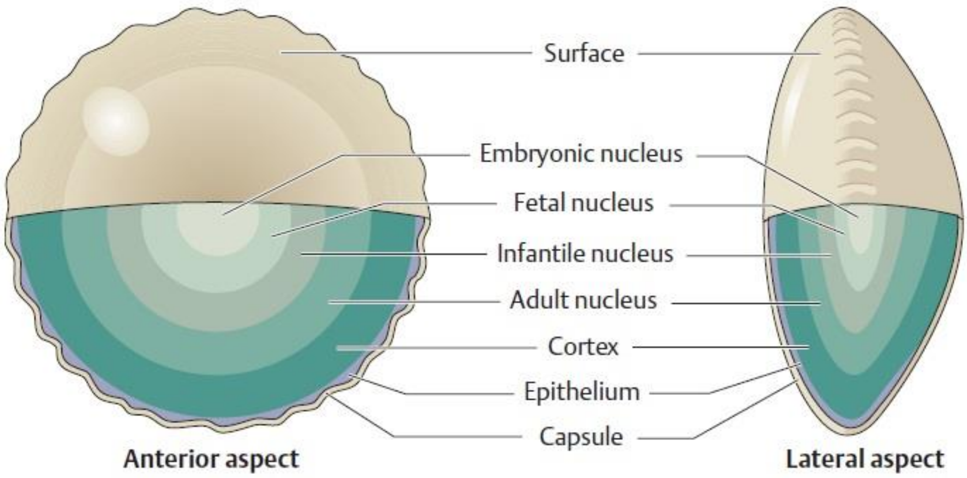

Figure 3. Anatomy of the lens taken from Lang G. Ophthalmology. Stuttgart: Thieme; 2007

1.2 Innervation

The sensory innervation of the eyelids, the eye and the orbit is supplied by the first two branches of the trigeminal nerve, the ophthalmic nerve and the maxillary nerve (4). The lower eyelid is supplied by branches of the maxillary nerve, specifically the infraorbital nerve and the zygomatic nerve. The upper eyelid is supplied by the third branch of the ophthalmic nerve, the nasociliary nerve (3,4). The other two branches of the ophthalmic nerve, the frontal nerve, divided into the supraorbital and supratrochlear nerve, and the lacrimal nerve are responsible for sensory innervation of the orbits (4). Sensory innervation of the cornea, iris and ciliary body is supplied by the long ciliary nerves, which later join the nasociliary branch of the ophthalmic nerve (3,4).

Still divided in its three branches the ophthalmic nerve leaves the orbit through the superior orbital fissure to then join the trigeminal ganglion before further transmission to the brainstem occurs (5). After synapsing in the brainstem, second order neurons decussate to join the spinothalamic tract and travel to the thalamus and synapse on third order neurons (6). Furthermore, signals are conveyed to the periaqueductal gray, hypothalamus, amygdala and prefrontal cortex for the emotional aspect of pain (7).

The cornea is the most densely innervated tissue in the body. Neurons in the cornea can be either thin myelinated, called A-delta type, or unmyelinated, called C-type. This leads to differences in conduction velocity, which is higher in the A-delta type (8).

There are multiple receptor types in the eye allowing for the recognition of stimuli from diverse sources. Firstly, there are mechano-nociceptors, which respond to a mechanical force strong enough to potentially damage the corneal epithelial cells. Mechano-nociceptors make up around 20% of corneal sensory neurons and are all thin myelinated. These receptors are classified as phasic sensory receptors, meaning they fire one or at most a few nerve impulses after being stimulated. This leads to them only signaling the presence and to some degree intensity of a stimulus, but not the duration (9). Another type is the polymodal nociceptor, which makes up 70% of the corneal sensory fibers. They can be activated by mechanical force, but also heat, exogenous chemical irritants and a large variety of endogenous chemical mediators released by damaged cells or inflammatory cells (10). Polymodal nociceptors are mostly of the C-type and have a continuous, irregular discharge pattern allowing for signaling of the intensity and duration of the stimulus (10). Together the mechano-nociceptors and the polymodal nociceptors are responsible for the sharp mechanical pain that arises after exposure of the cornea to mechanical force. In addition, the polymodal nociceptor produces sustained sensations of pain in inflammation (11). Another category of receptors are the cold-sensitive receptors, accounting for 10-15% of sensory fibers in the cornea. Cold-sensitive receptors fire spontaneously at rest and increase their firing when the temperature of the corneal surface drops below its normal temperature of 33°C (12). Lastly a fourth type of receptor has been suggested, which only becomes responsive to stimuli in the presence of inflammation (13). These types of receptors found in the cornea can also be found in the sclera, the iris and the ciliary body (14).

1.3 Cataract epidemiology

A transparency is termed cataract when the transparency of the lens is reduced to a degree where the vision of the patient is impaired. The term cataract comes from the Greek word *katarraktes* (downrushing; waterfall) because it was thought that cataract fluid from the brain that had flowed down and in front of the lens (3).

Cataract is a common cause of visual impairment. It makes up a big part of the workload of most ophthalmologists and cataract surgery remains to be the commonest elective surgery procedure in lot of countries (15). Thirty percent of people in western Europe aged 65 years and older have visually impairing cataract in one or both eyes. A further 10% of people in this age group had previous cataract surgery in one or both eyes. The prevalence of visually impairing cataract rises steadily with age: 16% in the 65 to 69 year age group, 24% in people of 70 to 74 years of age, 42% in those 75 to 79 years of age, 59% in those 80 to 84 years, and 71% in people of 85 years or more (16). The number of blind people due to cataract are on a rise worldwide because of the population aging; it went from 12.3 million in 1990 to 20 million in 2010. The highest prevalence of age-standardized blindness in adults older than 50 years is in sub-Saharan Africa. Despite this, from 1990 to 2010 the rate of blindness due to cataract decreased in most developed countries (17). In connection to this, cataract surgery rates are increasing worldwide. Overall women have a higher rate of cataract, age-standardized prevalence of cataract blindness in 2010 was 0.19% in women and 0.13% in men (17).

1.3.1 Risk factors

There are multiple factors influencing the development of cataract. Beside the age, studies have identified gender, sunlight, steroids, diabetes mellitus, nutrition and socio-economic status, lifestyle-smoking and alcohol and dehydration/diarrheal crises also as risk factors for cataract development (18,19). Furthermore, recent data suggests that the heritability of age-related cataract could be between 48% - 59% (20).

1.4 Signs and symptoms of cataract

The development of cataract is usually a slow and occult process. The various symptoms include visual impairment, seeing only shades of grey, blurred vision, distorted vision, glare or star bursts, monocular diplopia, altered color perception etc. to varying degrees (3).

In general cataracts are either classified as acquired or congenital and then subdivided further by their etiologies (2). The majority of acquired cataracts are senile cataracts, which make up around 90% of all cataracts, others are secondary cataract which are associated to systemic disease, for example diabetes mellitus, postoperative cataract, traumatic cataract and toxic cataract (3). Besides this, cataracts can also be classified according to their maturity. It is being differentiated between immature, mature, hypermature and Morgagnian cataract. Immature cataract means the lens is partially opaque, consequentially mature cataract means the lens is completely opaque. In case of hypermature cataract the anterior capsule is wrinkled and shrunken, because water leaked out of the lens. Finally, Morgagnian cataract presents with liquefaction of the cortex, which leads to the nucleus sinking inferiorly (2,3).

Regarding acquired cataracts, senile cataracts are also classified according to their morphology and location. This classification includes the following main categories: nuclear, cortical and subcapsular (21).

In Nuclear cataract the increasing pressure with time causes a hardening of the lens, especially the nucleus. There is a discoloration of the nucleus as it takes on a yellowish to brown color (21). With this type of cataract there is lenticular myopia because of an increase in refractive power and sometimes monocular diplopia due to the development of a second focal point (3).

Subcapsular cataract can be anterior, with the opacity just under the lens capsule or posterior, being located just in front of the posterior capsule. Anterior subcapsular cataract is associated with fibrous metaplasia of the lens epithelium (21). In case of posterior subcapsular cataract, a plaque-like appearance is visible on oblique slit lamp examination and on retroillumination there are Wedl cells, which are swollen migratory lens epithelial cells (21). Posterior subcapsular cataract has a major impact on vision and patients are often troubled by glare (3,21).

Cortical cataract can affect the anterior, posterior or equatorial cortex and is characterized by changes in the water content and typical associated morphological changes on slit lamp examination. Those changes include vacuoles, water fissures, separation of the lamellae and cuneiform cataract (3,21). Cortical cataract generally progresses more rapidly than nuclear cataract and patients typically have an acquired hyperopia (3). As with subcapsular cataract, glare is a common symptom in this type of cataract (3,21).

1.5 Cataract management

Cataract surgery is the most frequently performed surgical procedure not only in ophthalmology but in general. Surgery is indicated if vision is impaired in bilateral cataract and in the presence of mature cataract. Surgery may be postponed for unilateral cataract as long as vision on the healthy eye is sufficient (3).

Prior to surgery a full ophthalmic examination should always be performed, including the test for corrected distance visual acuity (CDVA). There is no specific CDVA limit for undergoing surgery and final decision to do surgery should depend on the CDVA, also of the better eye and cataract symptoms (22).

Ocular comorbidity in the eye to be operated on is commonly found, according to the European Cataract Outcomes Study in up to 37.5%. Even though not a contraindication for surgery, it is associated with poor subjective and objective outcome (23). Also, there are some factors that lead to the surgery being classified as difficult or complex. These include previous corneal refractive surgery, previous vitreous surgery, small pupil with need for mechanical stretching, dense cataract with need for staining and corneal opacities (24).

Phacoemulsification is the standard of care for cataract extraction. Depending on the condition of the anterior chamber, iris and lens, extracapsular cataract extraction may be used in some cases. In a study analyzing European databases, phacoemulsification was used in 99.5% of cases (25). There are three different phacoemulsification techniques available: "divide and conquer", "phaco chop" and "stop and chop". Which technique is used is chosen by the surgeon depending on his preference or experience with a specific technique (21).

Another aspect of management is the choice of the intraocular lens (IOL) to be implanted. Studies suggest that hydrophobic acrylic lenses and/ or a square-edged optic profile lead to less posterior capsule opacification after surgery (26,27). The study analyzing European databases found that hydrophobic acrylic IOLs were implanted in 80.8%, a hydrophilic acrylic IOL in 14.0% and silicone IOLs in 3.5%. They recommend hydrophobic acrylic IOLs and state that problems occur with every type of IOL (25). A problem of hydrophobic acrylic IOLs though is glistening (28).

Visual outcomes were reported as measurements of the CDVA by one study. 84% of patients achieved a CDVA of 0.5 or better. Rates were higher for patients without any ocular comorbidities (29).

1.6 Perception of pain

Pain and the perception of pain are a very complex area of research which combines different fields of medicine to reach a better understanding of the underlying processes. Pain is a subjective experience as the patient him/herself is able to evaluate it. The perception of pain is influenced by a variety of factors. Studies have found race, ethnicity or culture and sex to have an influence on the pain perception of the individual (30). Some studies showed that women had a tendency to rate the stimuli as more unpleasant and more intense than men (31, 32).

Unfortunately, studies often neglect the cultural and psychosocial effects of pain such as group cohesion, financial status and the patient's confidence in the treatment (33). Additionally, it was found that, if healthcare professionals do not perceive the description of pain as credible, this increases the patient's loneliness, helplessness and (34).

When it comes to communication with the patient and how pain is perceived, the literature suggests that instructions and social information affect brain systems associated with the generation of pain and emotion and that influences of social observation, instructions, and suggestions do not only induce superficial changes in reporting or compliance. Instead, these processes seem to change affect-related physiological responses. Further, expectations have an important role in instruction and suggestion effects. They are key mediators of placebo and nocebo effects (35). Therefore, good communication is important for patients and can elicit placebo effects: true psychobiological effects not attributable to the medical-technical intervention. However, it is often unclear which communication behaviors influence specific patient outcomes (36). One study suggested that one of the ways to implement this was distraction as in drawing the attention away from the painful stimulus decreases the perceived pain intensity, which is what this pilot study will focus its analysis on (37).

2. OBJECTIVES

The aim of this study was to analyze how patients experience pain during cataract surgery and the possible impact of speaking to the patients during the procedure.

According to our hypothesis, patients that are being talked to by the surgeon will experience the surgery as less painful.

3. SUBJECTS AND METHODS

3.1 Ethical approval

The consent for conduction of this research was obtained from the Ethical Committee of the University Hospital of Split. In accordance with the Medical Code of Ethics, the data obtained in this research was and will be kept and handled strictly confidential. The purpose of the examinations, procedures, possible advantages, disadvantages and possible side effects of the intervention were explained to all participants, possible questions were answered, and a signed informed consent was obtained.

3.2 Subjects

We collected 57 patients eligible for the study from the cataract surgery waitlist. They were randomly divided into two groups using online service available on the webpage random.org on a day to day basis according to the operating schedule. Both groups underwent the same procedure with the same surgery method being used, which was phacoemulsification. Also, both groups were operated by the same surgeon. One group, the control group underwent the procedure with the minimum instructions from the surgeon necessary for the operation, being the only communication or interaction to take place. The second group, the interventional group, underwent the procedure with the same instructions, but additionally the surgeon kept communication going, talking about general, neutral topics to the patients. An example would be to start a conversation about the place where the patient lives and continue depending on the patients answer, avoiding too personal questions, such as about family members, their jobs etc. This type of conversation was chosen by a psychologist as a good neutral ground for a conversation.

Before undergoing surgery, all patients signed the informed consent form. Additionally, they filled out two questionnaires, the Spielberger State-Trait Anxiety Inventory six-item short-form (STAI: Y-6 item) and the Pain Catastrophizing Scale (PCS) (see section 11. Supplement). The STAI: Y-6 item was used to evaluate how the patients were feeling at that moment and the PCS served to identify how the patients deal with pain in general.

For the STAI questionnaire patients had to grade six items with how appropriately they describe how they currently feel. Answer possibilities range from not at all to very much and are valued with one to four points. Scores for the positive items like calm, content and relaxed were reversed and then all scores were summed up and multiplied by 20/6 for the total score.

Total scores can range from twenty to eighty and in general a normal score is considered to be between 34 and 36.

For the PCS patients are asked to indicate the degree to which they have the thirteen thoughts and feelings on the questionnaire using the numbers zero (not at all) to four (all the time). The questions are grouped in three subcategories that not mentioned on the questionnaire. The subcategories are rumination, magnification and helplessness. A total score is yielded, which can range from 0-52.

Additional data collected included the duration of the surgery for each individual patient, whether they underwent prior cataract surgery on the other eye or not and whether there were any complications during surgery or not. After surgery the patients filled out the STAI: Y-6 item again to evaluate any changes in their mood. They were also asked to quantify the pain and discomfort they felt, for this a numeric rating scale was used. The order in which these steps were executed is depicted in Figure 4.

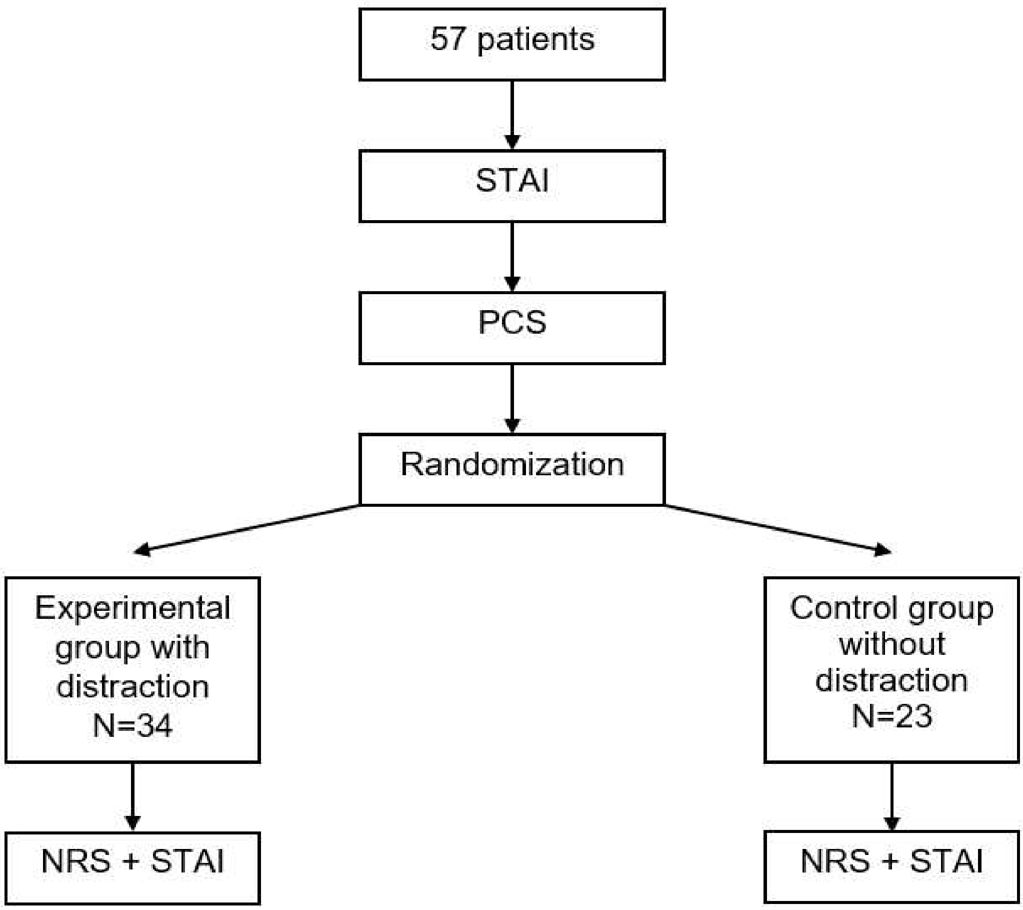

Figure 4. Study flow chart

3.3 Methods

Prior to surgery, Novesine 0.4% (oxybuprocainhydrochlorid 4mg/ml) was applied to achieve appropriate topical anesthesia. At the start the operating field was prepared by instilling the conjunctival sac with 5% povidone-iodine, which is left undisturbed for three minutes and then carefully draped to remove the lashes and lids from the operating field. Next a speculum was applied. Then a corneal tunnel was created as well as two side ports, since a bimanual surgery technique was used. The viscoelastic was injected to stabilize the anterior chamber. After that curvilinear capsulorhexis was performed, hydrodessication followed to separate the nucleus from the capsule sac. With mobilized nucleus, phacoemulsification was done with the "divide and conquer" technique making two perpendicular grooves, cracking the nucleus into four quadrants. The device that was used was the Infinity (Alcon, USA). When phacoemulsification was completed, an intraocular lens was inserted and then the wounds were hydrated with subsequent application of Cefuroxim in the anterior chamber.

3.4 Statistical analysis

Differences were tested for by using two-tailed t-test. For analysis of correlation between all studied parameters Pearson's correlation was used. Data are expressed as mean ± standard deviation and 95% confidence interval is given for correlation analysis. Significance level was set at $p < 0.05$. Statistical analysis was done using Statistica 10 statistical software (StatSoft, Tulsa, United States).

4. RESULTS

The study included a total of 57 surgeries that were included in the analysis. The characteristics of the study group are shown in Table 1. There was a predominance of female patients in the study group with 42 out of 57, amounting to 73.68%. Twenty-one point zero five percent of patients had previous eye surgery of the other eye. But data was only available for 37 out of 57 patients regarding this. Random distribution of patients into the interventional or the control group led to 34 out of 57 patients or 59.65% being in the interventional group and 23 out of 57 in the control group.

Table 1. Study group characteristics: Frequencies in the groups

	Frequency [in n/N]	Frequency [in %]	Total
Female	42/57	73.68%	42
Male	15/57	26.32%	15
Intervention	34/57	59.65%	34
Control	23/57	40.35%	23
Other eye surgery	12/57	21.05%	12

We did not find any statistically significant difference regarding the results of the two questionnaires, which were filled out before the intervention, the STAI: Y-6 item (P=0.927) and the PCS (P=0.415) between the intervention group and the control group (Table 2).

Table 2. Questionnaire results prior to surgery

	Intervention (N=34)	Control (N=23)	***P****
STAI	36.97±17.88	36.52±18.56	0.927
PCS score	10.09±12.57	13.00±13.99	0.415

Data are presented as mean ± standard deviation

*t-test

As shown in Table 3, the results of the STAI: Y-6 item (P=0.926) after the intervention as well as the NRS (P=0.073) and the measured duration of the surgical procedure (P=0.154) did not show any statistical significant difference between the interventional group and the control group either.

Table 3. Questionnaire results post-surgery and surgery duration

	Intervention (N=34)	Control (N=23)	*P**
STAI	21.65±3.74	21.74±3.62	0.926
NRS score	1.62±1.79	2.74±2.85	0.073
Duration (in min.)	6.882±2.0266	7.609±1.588	0.154

Data are presented as mean±standard deviation
*t-test

We also saw a significantly higher results of the STAI questionnaire before surgery (36.79±17.99) and STAI questionnaire after surgery (21.68±3.66) when looking at the whole study population ($P<0.001$).

When analyzing the correlation of variables in our data we found no significant correlation between the pre-interventional STAI: Y-6 item and the post-interventional STAI: Y-6 item (r=0.008). This is shown with a 95% confidence interval in Figure 5.

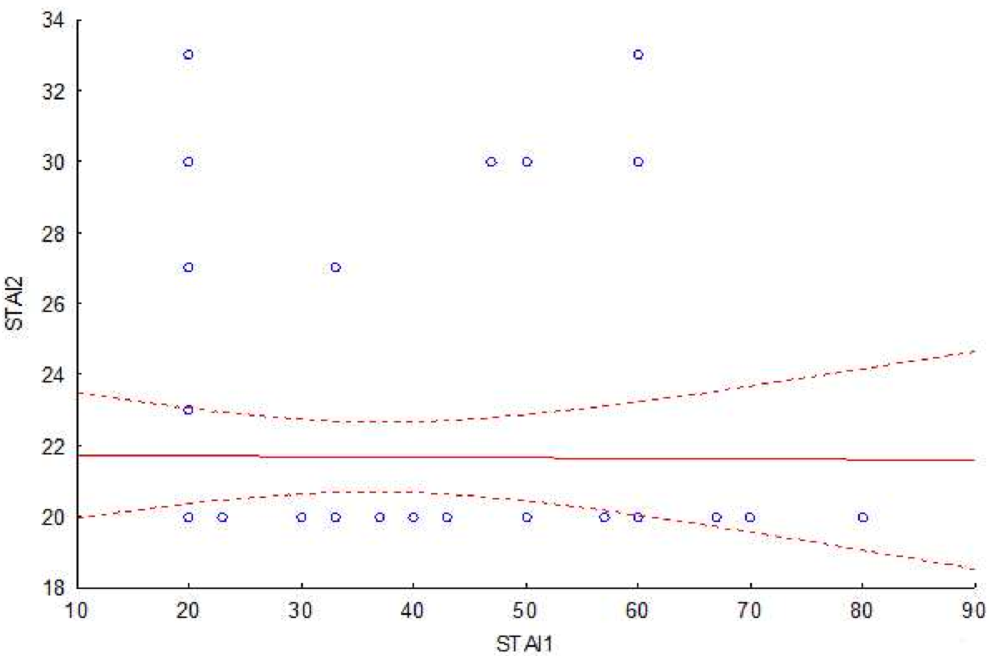

Figure 5. STAI 1(pre-intervention) vs. STAI 2 (post-intervention)
Data are presented as correlation of STAI 1 and STAI 2 with 95% CI
*Pearson's correlation, r=-0.008, *P*=0.951

Further analysis of the correlation between the Pain Catastrophizing Scale results and the NRS results also showed no statistical significance (r=0.014). This is again shown with a 95% confidence interval in Figure 6.

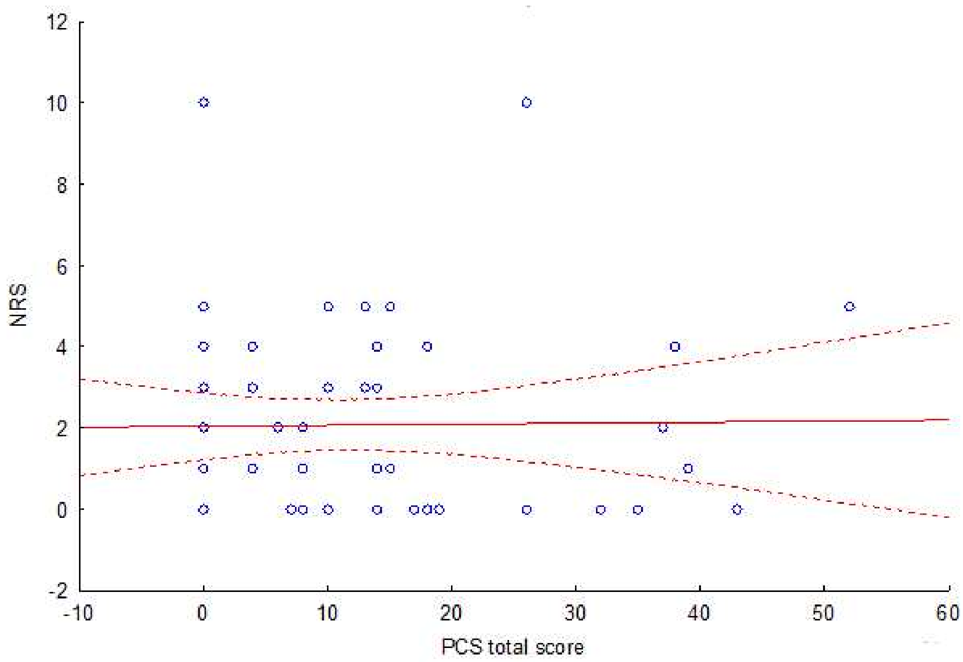

Figure 6. PCS total score vs. NRS score

Data are presented as correlation between PCS and NRS with 95% CI

*Pearson's correlation, r=0.014, *P*=0.917

There was some correlation between the NRS scores and the duration of the surgeries (r=0.198), which can be seen in Figure 7. But this also was not statistically significant (P=0.141).

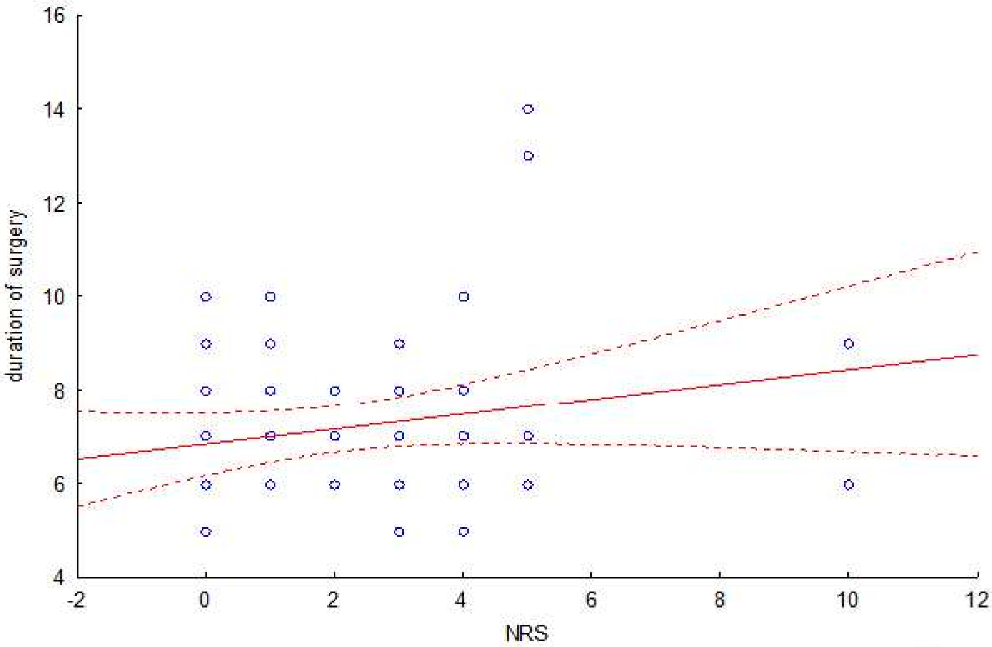

Figure 7. NRS vs. duration of surgery

Data are presented as correlation between NRS score and duration of surgery with 95% CI

*Pearson's correlation, r=0.198, *P*=0.141

Another correlation that was of significance was between the NRS scores and the STAI results after surgery with a Pearson's correlation of r=.0418 (P=0.001).

Last we looked at the differences between male and female patients (Table 4). In general PCS scores were higher in the male patient population, while only being significantly higher, when looking at the helplessness section of the PCS (P=0.032). No significance was found when comparing the STAI 1 (P=0.168) and NRS (P=0.903) results. Another significant difference could be seen in the STAI 2 results (P=0.021).

Table 4. Comparison of men and women

	Male (N=15)	**Female (N=42)**	***P****
PCS rumination	2.07	4.45	0.117
PCS magnification	1.67	2.78	0.267
PCS helplessness	2.13	5.98	0.032
PCS total score	5.87	13.19	0.062
STAI 1	31.27	38.76	0.168
NRS	2.13	2.05	0.903
STAI 2	23.53	21.02	0.021

Data are presented as mean

*t-test

4. DISCUSSION

In this pilot study we assessed the pain perception of 57 patients during cataract surgery and the impact of distracting the patients during the procedure by engaging them in a conversation with the surgeon. Even though we were not able to confirm our hypothesis and show a significant reduction in pain experienced during surgery in the experimental group compared to the control group, NRS scores were lower. Given the borderline insignificance, including more patients and thereby increasing the sample size might lead to new results in this regard.

Besides this, some other observations can be made about pain perception during cataract surgery. Our analysis of the correlation between the results of the STAI prior to surgery and the results of the STAI after surgery, which showed no correlation leads to the assumption that the patient's general feelings before the procedure did not influence the how they felt after the surgery. This is a different result than from another study, which found anxiety to be an important predictor in post-operative pain especially in gastrointestinal, obstetrical and gynecological surgery (38). Interestingly though, STAI results were significantly lower after surgery. This could be, because they were calmer after the surgery was over and there were not any complications. In connection to this we also were able to show a significant correlation between the NRS scores and the STAI results after the procedure, meaning patients who perceived the procedure as more painful also felt worse after the intervention was over.

Furthermore, there also was no correlation shown between the total PCS scores and the NRS scores. Again, this differs from another study done at the University Hospital Split in 2016 that showed a significant correlation between the two (39).

The correlation between NRS scores and duration of the surgery, even though not significant, should be mentioned. Since cataract surgery in general is a very short procedure, our measured intervention time was ranging from 5-14 minutes with an average of seven minutes, the influence is expected to be small. But this correlation could be interesting to analyze for other ophthalmologic interventions, which require more time.

Differences in the results of the subsections of the PCS in male and female patients indicate that women and men in general have a different perception of pain and deal with it differently. This was significant in the PCS helplessness subsection, meaning women felt more helpless when confronted with pain. An analysis of the impact of the intervention specifically on women and a correlation with the PCS scores were not part of this study. Therefore, future studies could evaluate this to see, if surgeon communication has additional value for female patients. Men and women also significantly differed in the STAI results after the procedure. Both had lower scores after the surgery than before, but women had a bigger decrease in their STAI results. These differences are in accordance to traditional believes, but the other study form the University Hospital Split did not find a significant influence of sex on pain experienced after surgery (39).

As mentioned before in regard to our hypothesis, this was a pilot study and further investigations with bigger sample sizes should be made to evaluate the correlation of different factors influencing pain perception during modern cataract surgery which, per se, seems to induce low level pain and discomfort. Besides the small sample size, there are other limitations of this study, like the disbalance between the number of men and women participating in the study. Also, there are other factors that have been shown to influence or are believed to influence pain in cataract surgery which were not looked at in this study. One of these is whether surgery was performed on the dominant eye or not, which was shown to have significantly more pain (40). Also, previous eye surgery seems to have an influence, even though data are conflicting. According to two studies pain was significantly increased in second eye surgery (41,42), whereas one other study found no impact (43). Also, age, on which this study did not collect any data, was identified as an important factor to be measured in the context of pain. Due to population aging, it has been suggested that research into the assessment of postoperative pain in older patients is urgently needed (44).

In conclusion this pilot study was not able to show a significant impact of distraction on pain perceived by patients during cataract surgeries. Nevertheless, it identified differences in pain perception between male and female patients as well as a larger decrease in anxiety in women after surgery compared to men. Also, a correlation between duration of surgery and pain was established.

6. CONCLUSION

1. In our study we were not able to show a significant influence of distraction by speaking to the patient on pain perception during cataract surgery.
2. Women felt significantly more helpless in their pain perception in general.
3. STAI results were significantly lower after the surgery than prior and women showed a larger decrease in STAI results.
4. NRS scores increased with increased duration of surgery to a small degree.

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8. SUMMARY

Objectives: The aim of this study was to analyze how patients experience pain during cataract surgery and the possible impact of speaking to the patients during the procedure.

Materials and methods: Fifty-seven patients that were to undergo cataract surgery were enrolled in the study and randomly assigned to an experimental or a control group after they filled out the STAI and PCS. The experimental group was distracted during the procedure by the surgeon speaking to them. NRS and STAI once again were used after the procedure to evaluate how pain was perceived.

Results: No significant difference in pain perception could be shown between the experimental and the control group. But there were significant differences between men and women in their pain perception shown by the results of the PCS helplessness section as well as the post interventional STAI results. Also, some positive correlation was found between duration od surgery and NRS results.

Conclusions: As of now distracting patients by speaking to them could not be proven to aid in decrease pain perceived during cataract surgery.

9. CROATIAN SUMMARY

Naslov: Percepcija boli tijekom operacije katarakte

Ciljevi: Cilj ovog istraživanja je ispitati kako pacijenti doživljavaju bol tijekom operacije katarakte i mogučnost comunicacije dokum operacije.

Bolesnici i metode: Uključeno u istraživanje su pedeset sedam pacijenata koji su imali operaciju katarakte. Nakon randomizirane dodjele sudionika u eksperimentalnu ili kontrolnu skupinu, pacijenti su ispunili STAI i PCS. U eksperimentalnoj skupini, kirurg je tijekom operacije nastojao usposobit kontakt sa pacijentima, te sa pacijentima iz kontrolne skupine nitko nije govorio tijekom operacije. NRS i STAI su još jednom korišteni nakon operacije za procjenu percepcije boli.

Rezultati: Istraživači nisu pronašli značajne razlike u percepciji boli između eksperimentalne i kontrolne skupine. Međutim, postojalo je značajne razlika između muškaraca i žena u njihovoj percepciji boli. Ovo je potvrđeno rezultatima iz podsekcije bespomoćnosti PCS-a kao i rezultatima post-intervencijskog STAI-a. Također je pronađena pozitivna korelacija između vrijemenski period operacije i rezultata NRS-a.

Zaključci: Odvlačenje pažnje pacijenata govorom nije dokazano da je efikasno u smanjivanje boli tijekom ili nakon operacije katarakte.

10. CURRICULUM VITAE

Personal Information

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2013 – 2019	University of Split, School of Medicine
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11. SUPPLEMENT

Pain Catastrophizing Scale

Označite koliko se sljedeće izjave odnose na Vas koristeći ljestvicu od 0-4.

0 (nimalo) 1 (malo) 2 (djelomično) 3 (gotovo uvijek) 4 (u potpunosti)

Kada me boli.....

---

1. Stalno brinem o tome kada će bol prestati
2. Osjećam kao da ne mogu dalje
3. Osjećam se užasno i imam osjećaj da mi nikada neće biti bolje
4. Osjećam se užasno i to me nadvladava
5. Osjećam se kao da to više ne mogu podnositi
6. Bojim se da će se bol pojačati
7. Stalno razmišljam o ostalim bolnim događajima
8. Tjeskobno iščekujem da bol prestane
9. Ne mogu prestati misliti na bol
10. Neprestano mislim na to koliko me boli
11. Neprestano mislim na to koliko želim da bol prestane
12. Ne mogu napraviti ništa da bi ublažio intenzitet boli
13. Razmišljam može li mi se nešto ozbiljno dogoditi

Departments of Psychology, Medicine, and Neurology; School of Physical and Occupational Therapy; McGill University; Montreal, Quebec; H3A 1B1

Spielberger State-Trait Anxiety Inventory (STAI: Y-6 item)

Objavljen :

Marteau TM and Bekker H. The development of a six-item short-form of the state scale of the

Spielberger State-Trait Anxiety Inventory (STAI). *British Journal of Clinical Psychology.*

1992;**31**:301-306.

Ime i prezime ……………………………………………………….   Datum ……………

Ispod se nalazi nekoliko izjava kojima ispitanici opisuju svoje osjećaje.

Pročitajte svaku izjavu i aokružite najprikladniji broj koji označava kako se osječate upravo sada.

Nema točnih i pogrešnih odgovora. Nemojte previse razmišljati o izjavama nego dajte odgovor koji opisuje vase trenutno stanje.

	Nimalo	**Ponešto**	**Umjereno**	**Jako puno**
1. Miran sam …...……………………	1	2	3	4
2. Napet sam ……………………..	1	2	3	4
3. Uzrujan sam ………..…………	1	2	3	4
4. Opušten sam …………………	1	2	3	4

5. Zadovoljan sam ……………..… 1 2 3
4

6. Zabrinut sam …………………..…… 1 2 3
4

Rezultati:

Kako bi izračunali STAI zbroj (raspon 20 - 80):

- obrnite bodovanje pozitivnih izjava (miran, opušten, zadovoljan) 1=4, 2=3, 3=2 and 4=1;

- zbrojite bodove za svih 6 izjava;

- pomnožite rezultat sa 20/6

- referirajte se na Spielbergerov priručnik za interpretaciju rezultata (uredan rezultat je između 34 - 36) ili **Bekker HL**, Legare F, Stacey D, O'Connor A, Lemyre L. *Is anxiety an appropriate measure of decision aid effectiveness: a systematic review?* Patient Education and Counselling. 2003; 50: 255-262.