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Francisco Carlos dos Santos Neto

Comparação Entre Métodos de Registro Fotográfico Intraoperatório

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Francisco Carlos dos Santos Neto

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Orientador: Dr. Sérgio Luis Amantéa

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LISTA DE ABREVEATURAS

AF - *automatic focus*

DSLR - *Digital Single-Lens Reflex*

etc. - *et Cetera*

f/ - abertura

HDMI *- High-Definition Multimedia Interface*

ISO - *International Standards Organization*

JPEG - *Joint Photographic Experts Group*

LCD - *Liquid Crystal Display*

Lx - LUX

MeSH - *Medical Subject Headings*

mm - milímetro

NBR - denominação de norma da Associação Brasileira de Normas Técnicas

PAS - *point and shoot*

RAW - formato de arquivo de imagem .RAW

SUMÁRIO

1. RESUMO

O registro fotográfico intraoperatório ainda é um assunto pouco explorado dentro da literatura médica, apesar da grande importância que esses registros tem estudo das ciências da saúde. A fotografia e vídeo intraoperatórios servem para variadas funções, tanto de ensino quantos legais. Propomos a avaliação de diferentes métodos de registro fotográfico intraoperatório em diferentes condições de iluminação.

Desenvolvemos um estudo descritivo comparando quatro tipos de câmeras fotográfica em duas modalidades de iluminação dentro de uma sala cirúrgica. Foram avaliadas por especialista quando a sete quesitos de qualidade de fotografia. Pra análise estatística entre as variáveis *(testes não paramétricos)* foi utilizado o teste U de Mann-Withney para comparar dois grupos independentes (entre luz) e o teste Kruskal-Wallis para comparar a mediana entre quatro grupos independentes (entre câmeras). Para todas as análises foram considerados valores estatisticamente significativos para $p \leq 0,05$.

No geral, houve diferença entre as notas das câmeras ($p<0,001$). Câmera point & shoot e profissional, Câmera point &shoot e celular e profissional e celular apresentaram medianas iguais. O destaque pode ser que o celular apresentou mediana (postos de média) do teste um pouco maior em comparação a todas as outras câmeras. A diferença principal é que o protótipo apresentou nota menor em relação as outras três câmeras ($p<0,001$).

Pelo presente estudo podemos inferir também que não há diferença em fazer fotografias com câmera profissional, comum ou do celular quando estão configuradas no modo automático. Utilizar o celular para efetuar o registro das fotografias pode ser uma alternativa prática, financeiramente aceitável, sem necessidade de pessoal especializado para configurá-lo e manuseá-lo sem que se perca qualidade nos registros fotográficos.

2. ABSTRACT

The intraoperative photographic record is still an unexplored subject within the medical literature, despite the great importance that these records have. Intraoperative photography and video serve a variety of functions, both teaching and legal. We propose the evaluation of different methods of intraoperative photographic recording in different lighting conditions.

Descriptive studies comparing four types of photographic cameras in two lighting modalities within a surgical room were evaluated by specialists regarding the seven quality photography requirements. For statistical analysis among the variables *(non-parametric tests),* the Mann-Whitney U test was used to compare two independent groups (between light) and the Kruskal-Wallis test to compare the median among four independent groups (between cameras). Statistically significant values for $p \leq 0.05$ were considered for all analyzes.

Overall, there was a difference between the camera scores ($p < 0.001$). Point & shoot auto mode and professional cameras, point & shoot auto mode and cellphone cameras and professional and cell phone cameras had the same median. The highlight may be that the cell phone camera had a median (average place order) of the test a little higher compared to all other cameras. The main difference is that the point & shoot manual mode presented a lower score than the other three cameras ($p < 0.001$).

By the present study, we can also infer that there is no difference in making photographs with professional cameras, common cameras or the cellphone cameras when they are configured in automatic mode. Using a cell phone to register photos can be a practical, financially acceptable alternative, without the need for specialized personnel to configure and manipulate it without losing quality in the photographic records.

3. INTRODUÇÃO

A documentação fotográfica em cirurgia plástica é de fundamental importância para a sua boa prática. Desperta interesse há várias décadas, como evidenciado no editorial do periódico *Plastic And Reconstructive Surgery já* em 1976 com o título *"On the necessity of precision photographic documention in plastic surgery"* (1). A fotografia de uso médico existe há cerca de 150 anos, quando Alfred Donne produziu a primeira imagem médica (2). Desde então, os métodos fotográficos vêm se aprimorando e o uso de documentação fotográfica de alta qualidade tornou-se obrigatório na cirurgia plástica. A fotografia pré-operatória é útil como ponto referencial do caso, como coadjuvante no exame clínico, como auxílio no planejamento cirúrgico, e na condução da cirurgia em sala cirúrgica. A fotografia pós-operatória é usada para fins de educação médica, pesquisa, documentação em prontuário médico e justificação legal (3). Entretanto, a documentação fotográfica intraoperatória possui particularidades distintas das demais citadas. Nela há a oportunidade de demostrar uma série dinâmica de eventos únicos e não reproduzíveis inerentes ao ato operatório. Dessa maneira, a documentação fotográfica transoperatória oportuniza a documentação do procedimento, auxilia na educação de cirurgiões em formação e especialistas; assim como, no auto aperfeiçoamento e pesquisa (3).

A era digital possibilitou aos cirurgiões o acesso a um adequado e qualificado equipamento fotográfico e maior facilidade de armazanmento de fotografias de alta qualidade. A fotografia é utilizada com frequência no período pré e pós-operatório. Já no intraoperatório encontramos maior dificuldade à sua utilização, uma vez que na sala de cirurgia são encontradas variáveis adversas não presentes no consultório médico (4). A necessidade de adaptação às condições distintas de iluminação, ao processo cirúrgico dinâmico, às restrições do ambiente estéril, ao enquadramento fotográfico dinâmico produzem dificuldades inerentes à sala cirúrgica, capazes de impactar de maneira negativa tanto no tempo operatório e condições de assepsia, quanto na qualidade da documentação fotográfica (4,5).

O presente estudo propõe comparar diferentes tipos de equipamentos fotográficos utilizados para documentação fotográfica intraoperatória no que tange à qualidade da fotografia.

3.1 PERSPECTIVA HISTÓRICA

HISTÓRIA DA FOTOGRAFIA

O termo fotografia pode ser entendido como “desenhar pela luz” e vem sendo desenvolvida e aprimorada desde o início do século XIX. A foto mais antiga conhecida foi produzida por Joseph Niece quando usou verniz de asfalto sobre uma placa de estanho. Seguindo seus estudos, Louis Daguerre desenvolveu um processo conhecido como “daguerreotipia em 1830. Apenas no início do século XX a fotografia colorida foi desenvolvida (6).

A portabilidade da câmera ganharia grande impulso somente em 1920 com as câmeras desenvolvidas por Kodak®. As câmeras instantâneas foram desenvolvidas entre 1940 e 1960 pela empresa Edwin Land e Polaroid®. A câmera digital desenvolvida por Steven Sasson substituiu o filme fotográfico por um sensor eletrônico que converte a luz em elétrons, facilitando a aquisição das imagens. Ela foi desenvolvida por em 1970 e atingiu enorme popularidade a partir dos anos 90. A partir dos anos 2000, a integração da fotografia digital com o telefone celular marca uma nova era de acessibilidade instantânea e portabilidade (6).

HISTÓRIA DA FOTOGRAFIA NA CIRURGIA PLÁSTICA

Alfred Donne, em 1840, com um microscópio-daguerreotipo realizou a primeira imagem com objetivo médico. Anos mais tarde, o cirurgião Gurdon Buck produziu a primeira documentação fotográfica pré-operatória. A primeira publicação de fotografias em periódicos médicos ocorreu em 1849. Já em 1870 surge o periódico *“The Photographic Review of Medicine and Surgery”*, dedicado aos estudos de casos fotografados (6).

Balossa, em 1963, foi reconhecido como realizador da primeira documentação fotográfica de uma cirurgia reconstrutiva com sete fotos de um caso de reconstrução nasal (2).

Harold Gilles, pioneiro da cirurgia plástica moderna, no seu discurso no Primeiro Congresso Internacional de Cirurgia Plástica, em 1955, afirmou que a fotografia representou o avanço mais importante na cirurgia plástica (2).

Em seu artigo, em 2016, Freshwater salienta que toda documentação científica deve ser apresentada com suficiente acurácia e precisão, para que possa ser analisada e reproduzida (8). O mesmo artigo ainda aborda aspectos da evolução histórica entre a relação do cirurgião plástico com o registro visual como documentação científica.

O cirurgião Gordon Buck publicou seu livro "*Contribuições para Cirurgia Reparadora*" em 1875, onde reuniu casos 29 casos, na maioria publicados em vários periódicos médicos entre 1864 e 1865. Os casos foram registrados com o processo fotográfico de Daguerre, entretanto foram publicados como gravuras; ainda não havia meios de reproduzir as fotografias nas publicações. Buck reconheceu sua limitação entre o uso da nova tecnologia, para registro visual, e a incapacidade de reproduzi-la. A publicação de fotografia somente foi possível a partir de tecnologia produzida por Ives Frederick, em 1890 (8).

A primeira publicação de fotografias relacionada à cirurgia plástica estética ficou a cargo de Kolle, em 1911. Ele dedicou as páginas finais de seu livro para detalhar de maneira minuciosa a metodologia para obtenção de fotografias clínicas (8,9).

3.2 FOTOGRAFIA

A MÁQUINA FOTOGRÁFICA

A câmera fotográfica é um equipamento que, independente de sua tecnologia, continua funcionar como uma câmera escura onde, por um orifício, a luz do meio externo é transformada em imagem e captada por um filme ou sensor. A luz da imagem é captada por um conjunto de lentes convergentes que a projeta sobre um filme (na câmeras convencionais) ou um sensor (nas câmeras digitais) (10).

George Eastman desenvolveu a primeira câmera instantânea em 1888 quando fundou a Eastman Kodak Company; fator de impacto na popularização da fotografia ao trazer o conceito de portabilidade no ato de fotografar, a partir do final do século XIX e início do século XX (11). A redução do custo do filme, da impressão, do espaço para armazenamento das fotografias contribuiu para a disseminação da fotografia digital. Além disso, a capacidade de conferir de maneira instantânea as imagens captadas numa tela de cristal líquido (*Liquid Crystal Display* – LCD) habilitou o fotógrafo a realizar a rápida seleção das fotografias (11).

As câmeras fotográficas são definidas em dois grandes grupos: *Digital Single Reflex Lens* (DSRL) e *point and shoot* (PAS). A principal diferença entre elas está na presença de um espelho interno para visualização do objeto a ser fotografas (12).

Nas câmeras PAS não existe um espelho refletindo a imagem antes de ela chegar no sensor. Dessa forma, essas câmeras necessitam de uma tela de LCD *(liquid cristal display*) para o fotógrafo pode ver a imagem que será registrada. Essa exposição constante do sensor à luz causa uma redução na vida útil do mesmo. Entretanto, a ausência de espelho interno permite que ela seja mais compacta e leve, facilitando o manuseio (12).

Nas câmeras tipo DSLR o sensor está protegido por um espelho, que desvia a imagem em direção a um visor óptico – ao contrário do LCD nas PAS. Dessa forma, o fotógrafo necessita aproximar o rosto da câmera para poder enxergar o objeto que será fotografado. Isso permite uma tradução mais real da cena, especialmente em ambientes com mais luminosidade. Porém, dependendo do ângulo da fotográfica, pode dificultar o enquadramento da imagem pela dificuldade de posicionamento (12).

PARÂMETROS FOTOGRÁFICOS E EXPOSIÇÃO

O olho humano é frequentemente comparado com a câmera fotográfica devido seu mecanismo ótico. Equivalências são referidas entre a íris com obturador; a pupila com o diafragma; a retina com o filme ou sensor de imagem. Entretanto, ao analisar mais criteriosamente as semelhanças entre o olho humano e a câmera fotográfica, encontra-se uma grande diferença entre os dois sistemas óticos. Na câmera a distância focal é fixa e mudança do foco é produzida pelo movimento entre as lentes. No olho humano a mudança de foco é dado pelo poder de adaptação de uma única lente (cristalino) ao variar a curvatura e produzir diferentes distâncias focais (13).

Para captura de uma fotografia com uma boa exposição, que é a luminosidade da cena, é necessário um equilíbrio do tripé formado pelos parâmetros de ISO *(International Standards Organization)*, abertura do diafragma e tempo de exposição (14). O equilíbrio adequado dos três parâmetros deve permitir uma fotografia com exposição adequada (15) e a alteração em qualquer valor dos parâmetros mencionados deve ser compensada pela alteração em um ou ambos parâmetros restantes para que seja possível manter a mesma captação de luz pelo sensor ou filme da máquina fotográfica (16,17).

O ISO corresponde à sensibilidade do filme ou do sensor da máquina fotográfica à luz. Quanto maior o número indicado para o ISO, maior a sensibilidade para a luz. Um filme com ISO 1600 capta melhor a luz que um filme com ISO 200 (10,14). ISO demasiadamente alto pode causar ruídos na fotografia, correspondendo a pontilhados e aberrações cromáticas que dão aspecto granulado a fotografia (16).

A abertura do diafragma (f/) – posicionado entre a lente e o sensor (ou filme) – controla a quantidade de luz que chega ao mesmo. Quanto mais aberto está o diafragma, maior a quantidade de luz que chegará ao sensor. É indicado na forma (f/) e seu valor e inversamente proporcional a abertura do diafragma (14). Valores baixos de (f/) (abertura grande do diafragma) leva a perda da profundidade de campo (16).

Por fim, a velocidade ou tempo de exposição determina o tempo que o obturador ficará aberto e irá expor o filme ou sensor à luz. Assim, quanto mais tempo o obturado ficar aberto, maior será à exposição à luz, ou seja, mais luz atingirá o sensor em uma mesma abertura de diafragma. As velocidades são dadas em segundos e suas frações (14). Tempo grandes de abertura promoverão fotos mais "dinâmicas" com tendência a borrar os sujeitos ou objetos à menor movimentação do fotógrafo ou fotografado (16,17).

TIPOS DE LENTE

Existem basicamente três tipos de lentes para máquina fotográficas do tipo DSLR: ângulo aberto, padrão e teleobjetivas. As lentes de ângulo aberto variam na distância focal de 8mm a 35mm. Proporcionam uma boa profundidade de campo e aumentam significativamente o ângulo de visão. Causam distorção da imagem tipo olho de peixe (17).

As lentes padrão são as que produzem imagens mais próximas ao olho humanos, possuindo uma distância focal de 35 a 55 mm com ângulo de visão de 45^{o} (16). Pela característica de produzirem imagens que parecem normais (semelhantes às vistas pelo olho humano) possuem um grande gama de aplicações e são as mais comumente encontradas (17).

Ângulo de visão estreitos e magnificação extra são as principais características das lentes teleobjetivas. Apesar de perderem em profundidade de campo, conseguem captar partes menores da cena, detalhando o objeto/sujeito a ser estudado (17).

O ângulo de visão é influenciado pela distância focal da lente. A distância focal é a distância da lente até o ponto onde os raios de luz convergem para formar uma imagem nítida de um objeto sobre o filme ou sensor digital. A variação dessa medida traz alterações sobre o ângulo de visão (o quanto da imagem é captada) e sobre a ampliação (o tamanho dos elementos) da imagem. Quanto menor a distância focal (exemplo: lente 18 mm), maior o ângulo de visão e menor a ampliação. O olho humano corresponde uma lente fotográfica de cerca de 50 mm de distância focal, com similar ângulo de visão e ampliação percebida pelo olho humano (18).

Na fotografia intraoperatória, um parâmetro de grande importância é a profundidade de campo. Esta é caracterizada como a distância entre o objeto mais próximo e o mais distante em uma imagem que estão com foco adequado (17). Os dois fatores que mais influenciam na profundidade de campo em uma fotografia são a distância focal da lente em uso e a abertura do diafragma (16,17). Grandes distâncias focais e diafragmas muito abertos (valores de (f/) pequenos) acarretam em perda da profundidade de campo. O contrário também é verdadeiro. Lentes de ângulo aberto proporcionam as melhores profundidade de campo (17).

3.3 AVALIAÇÃO DE IMAGEM

HISTOGRAMA DE UMA IMAGEM DIGITAL

A imagem digital é composta por uma matriz de valores inteiros e positivos de pixels que indica cada posição (x, y) da imagem. O pixel corresponde ao da intensidade da cor e posição de cada ponto formador de um todo percebido como imagem.

O histograma é um gráfico representativo de distribuição de frequência de uma variável em análise estatística. Na fotografia, o histograma mostra a distribuição faixas tonais de uma imagem. O eixo horizontal representa os tons da imagem. O tom preto se encontra no extremo esquerdo do gráfico e o tom branco no extremo direito. O meio do eixo horizontal representa o meio tom. (19).

3.4 ILUMINAÇÃO NO AMBIENTE CIRÚRGICO

Luz é uma radiação visível como energia em forma de ondas eletromagnéticas captadas por um sistema ótico – como olho humano – e interpretadas pelo cérebro como sensação visual. A luz é visível pelo ser humano numa estrita faixa de frequência com comprimentos de ondas entre 380 a 780 nanômetros. O raio ultravioleta, raio x e raio gama estão acima da faixa de frequência visível e o raio infravermelho, micro-ondas e ondas de rádio estão abaixo (21).

A distribuição da luminância no campo de visão influencia no nível de adaptação dos olhos, o qual afeta a visibilidade da tarefa. Uma adaptação bem balanceada da luminância é necessária para ampliar a acuidade visual (nitidez da visão), a sensibilidade ao contraste (discriminação das diferenças relativamente pequenas de luminância) e a eficiência das funções oculares (como acomodação, convergência, contrações pupilares, movimento dos olhos etc.) (22).

A distribuição de luminâncias variadas no mesmo campo de visão também afeta o conforto visual e convém que sejam evitadas. Luminâncias muito altas podem levar ao ofuscamento e contrastes de luminâncias muito altos causam fadiga visual devido à contínua readaptação dos olhos. Luminâncias muito baixas e contrastes de luminância muito baixos resultam em um ambiente de trabalho sem estímulo e tedioso (22).

Iluminância é a razão entre o fluxo luminoso emitido por uma fonte e a superfície iluminada a certa distância da fonte e é medida em Lux (Lx). A iluminância não é visível e pode ser medido com o auxílio de um luxímetro. A iluminância e sua distribuição nas áreas de trabalho e no entorno imediato têm um maior impacto em como uma pessoa percebe e realiza a tarefa visual de forma rápida, segura e confortável. Para lugares onde a área específica é desconhecida, a área onde a tarefa ocorre é considerada a área de tarefa. Convém iluminância aumentada em situações que: contrastes excepcionalmente baixos estão presentes na tarefa; o trabalho visual seja crítico; a correção dos erros seja onerosa; a exatidão e produtividade sejam importantes; ou a capacidade de visão dos trabalhadores esteja abaixo do normal (22).

Na sala de cirurgia, segundo NBR 8995-1, níveis de iluminância mais elevados são exigidos como no caso da cavidade cirúrgica com previsão de 10.000 lux até 100.000 lux. Para amenizar o desconforto gerado pela predominância do vermelho na tarefa cirúrgica, é recomendado usar no entorno cores complementares como o verde ou azul, utilizados nos campos cirúrgicos e roupas da equipe cirúrgica (22).

É também recomendado para o teto da sala cirúrgica a reflectância acima de 90%, para paredes acima de 60% (com cores claras e laváveis) e para o piso entre 20-30%. Os equipamentos cirúrgicos devem ser foscos para evitar reflexos (22).

3.5 PADRONIZAÇÃO FOTOGRÁFICA

PADRONIZAÇÃO NA MEDICINA

As primeiras documentações fotográficas não seguiam nenhum padrão. Os registros assemelhavam-se, em estilo, aos retratos clássicos da época (7).

Convenções na fotografia clínica moderna como uso de fundo liso, preservação da identidade do paciente e close-up da área de interesse não foram definidas antes de 1890 (7). O uso dos espelhos nas fotografias oportunizou o destaque da deformidade e diminuição de custos de produção, uma vez que tornava possível pontos de vistas distintos com a mesma fotografia (7).

PADRONIZAÇÃO DA FOTOGRAFIA PRÉ E PÓS OPERATÓRIA NA CIRURGIA PLÁSTICA

O registro médico antes e após as cirurgias plásticas seguem normas, nos EUA da *Plastic Surgery Educational Foundation* com o objetivo de alcançar acurácia na comparação entre imagens dos pacientes em períodos pré-operatórios e pós-operatórios (23,24). DiBernardo *et. al.,* em 1998, enfatiza que as fotografias clínicas devem ser sempre tomadas com a mesma lente da câmera, lente de configuração, iluminação e posição do paciente para garantir a reprodutibilidade e permitir validade prévia e comparações pós-operatórias (25).

Técnicas para melhor comparar as fotografias pré-operatória e pós-operatórias, na cirurgia plástica têm sido sugeridas para prevenir ou decodificar os resultados enganosos provocados como, por exemplo, de alterações posturais da cabeça ou do plano da câmera (26).

Fotos pré-operatórias de alta qualidade no nariz são de vital importância no planeamento na rinoplastia, na comparação de resultados e na demonstração dos resultados cirúrgicos. Para produzir fotografias de alta qualidade, é essencial padronizar a iluminação, posicionar corretamente o paciente em vistas padrão, evitar a distorção da lente, e de manter distâncias consistentes “câmara-assunto” (27).

Gherardini *et. al.*, em 1997, propuseram padronização nas fotografias dos pacientes antes e depois da cirurgia para evitar, por exemplo, análises pouco precisas de resultados como falsa melhora de dermolipodistrofias (28).

3.6 FOTOGRAFIA INTRAOPERATÓRIA

MOTIVAÇÃO E DIFICULDADES

O registro fotográfico ainda é um assunto pouco explorado dentro da literatura médica apesar da grande importância que esses registros tem. Em uma revisão sistemática feita por Gaujoux em 2016 e publicada no *Journal of Surgical Research*, apenas 5 artigos retornaram com resultados relevantes sobre fotografia intraoperatória (29).

A fotografia e vídeo intraoperatório servem para variadas funções, tanto de ensino quantos legais. Dentre as principais finalidades, destacam-se, publicações acadêmicas e protocolos de pesquisa, questões médico-legais, material de estudos de médicos e residentes em formação, avaliação do próprio médico e explicação e educação de novos pacientes (30). Para o cirurgião traz a possibilidade de rever os cada passo cirúrgico importante e, especificamente no caso da cirurgia plástica, compará-los com os desfechos. É uma ferramenta importante para constante revisão crítica dos resultados (30).

A fotografia médica em geral difere dos outros campos da fotografia em várias maneiras. Enquanto os demais ramos enfatizam na parte artística e farão o necessário para alcançar resultados esteticamente agradáveis; a fotografia médica reque imagens limpas e sem alterações, retratando de forma mais fiel possível a realidade. Alguns casos podem ser visto apenas uma vez na careira do médico e devem ser registrados com a maior precisão e veracidade possíveis, de forma padronizada (31).

Apesar de algumas instituições contarem com serviços de vídeo e fotografia especializados, eles são caros e requerem pessoas adicionais, o que aumento e tráfego de pessoas e equipamentos na sala cirúrgica, potencialmente comprometendo a esterilidade. O fotógrafo tem muitas vezes um campo visual limitado do procedimento, seja pelo posicionamento do cirurgião ou evitar a contaminação do campo cirúrgico (32). Um fotógrafo fora do campo cirúrgico, mesmo que profissional, raramente consegue o mesmo ponto de vista do cirurgião (30,33).Além disso, um dos maiores empecilhos ao registro fotográfico adequado é o tempo que é dispendido com cada fotografia, que acaba por aumentar o tempo cirúrgico (4).

TÉCNICA E CUIDADOS DA FOTOGRAFIA INTRAOPERATÓRIA:

O primeiro passo deve ser decidir quem será o responsável pelas fotografias durante o ato cirúrgico. Imagens mais consistentes e de maior qualidade podem ser obtidas se o mesmo fotógrafo for responsável por fotografias em todos os períodos. Selecionando uma pessoa diferente para registrar as fotografias em cada procedimento é improvável que se tenham imagens úteis, mesmo com os equipamentos mais avançados (4). O fotógrafo deve estar adaptado ao ambiente, procedimento e anatomia pertinente (29).O cirurgião é o mais indicado para o registro fotográfico, entretanto, não disponível, um médico em treinamento ou um assistente podem ser uma alternativa aceitável. Um fotógrafo fora do campo cirúrgico, mesmo que profissional, raramente consegue o mesmo ponto de vista do cirurgião (30,33).

É imprescindível destacar que o registro fotográfico não deverá de forma alguma comprometer a esterilidade do procedimento e o tempo cirúrgico. Uma forma comumente utilizada é a reserva de alguns pares de luvas extra para que o cirurgião vista, faça o registro fotográfico e retire a luva (4).

Humphrey sugere que o uso de uma câmera DSLR com lente macro de 60mm e flash em anel, selecionando uma abertura do diafragma de f/32, a velocidade do obturados em 1/100 segundo, em modo manual e ISO 200 é o mais indicado para registros intraoperatórios. Salienta ainda que o foco deve ser feito manualmente, assim o cirurgião pode decidir o objeto em destaque, e não a máquina. A abertura do diafragma entre f/22 e f/32 mantém uma profundidade de campo adequada para esta finalidade (4).

A fotos devem ser padronizadas em posição e distâncias, requerendo pouca ou nenhuma alteração nos ajustes das câmeras. Em geral, as melhores fotografias são em campos restritos, recortadas e com *close-up* próximo. Isso enfatiza o sujeito e elimina as distrações do campo cirúrgico e arredores (4). As lentes com zoom podem ser um transtorno mais que uma vantagem na fotografia médica devido ao fato que as fotos devem ser batidas a mesma magnificação para evitar distorções características da distância focal obtida, especialmente quando comparadas fotos de pré e pós-operatório (4).

Campos cirúrgicos novos, da cor azul ou verde, distraem menos para o fundo das fotos. Cuidados deve ser tomado para que o campo cirúrgico esteja com o mínimo de sangue possível, uma vez que sangue em excesso absorve grande quantidade de luz, prejudicando o acerto da exposição (4).

Manter os dedos e o mínimo de material metálico no campo fotográfico é outro cuidado fundamental. O uso de ganchos e retratores podem ser necessários em alguns momentos do procedimento e são aceitáveis, desde que limpos. Marcas na pele ou nos campos cirúrgicos e órgãos chave (orelhas, olho, sobrancelha, boca) podem ajudar o cirurgião ou o a pessoa que está vendo a foto a se orientar quanto a posicionamento e tamanho da lesão, assim como cotonetes para destacar pontos importantes e réguas para escala de tamanho. Devido a grande diversidade de procedimento e achados, não existe um posicionamento padrão para fotografia intraoperatória. Pontos de rotina para fotografia (por exemplo, em um mesmo momento do procedimento) podem ser úteis para o cirurgião (4).

A profundidade de campo é a área da fotografia em que o foco estará adequado e é distribuído aproximadamente em um terço à frente e dois terços atrás do plano focal. A profundidade campo é um conceito importante, especialmente quando se trabalha em cavidades ou em modo macro (34).

O objeto a ser fotografado deve estar centralizado, vertical e ortogonal ao campo cirúrgico com uma escala linear, para evitar erro de perspectiva – eixo craniocaudal deve estar vertical (29).

Algumas rotinas importantes devem ser seguidas no registro de fotografia intraoperatória, de acordo com Gaujoux (29):

- usar sempre a mesma câmera;
- remover acessórios desnecessários;
- sujeito centralizado;
- fotógrafo habituado com as rotinas e anatomia;
- distância de fotografia de 80cm e lentes com distância focal entre 80 e 100mm;
- zoom óptico preferido ao zoom digital;
- flash deve ser evitado e a luz cialítica usada no lugar;
- balanço de cores deve ser feito manualmente;

– áreas de interesse no centro da foto;
– campo cirúrgico seco e limpo;
– retirar instrumental de metal desnecessário;
– incluir elementos anatômicos chave;
– ISO menor que 400;
– autofoco no modo “single point AF” (ponto único);
– velocidade do obturados acima de 1/100;
– abertura do obturador pequena (abaixo de f/8);
– imagens gravadas em formato RAW e/ou JPEG;
– proteger a privacidade do paciente quando possível;
– termo de consentimento informado aplicado antes do procedimento autorizando o registro fotográfico;
– guardar imagens em computador seguro e protegido.

MODELOS PROPOSTOS

Existem diversos relatos na literatura de métodos de fotografia intraoperatória. Grande parte das publicações é baseada na experiência e opinião do autor, sem grupo comparativos e em um pequeno número de pacientes (4,35–41).

Tavares descreve a utilização de uma capa à prova de água em uma câmera fotográfica digital, permitindo ao próprio cirurgião registrar as diversas etapas cirúrgicas sob o seu próprio ângulo de visão. As principais vantagens do método são: assegurar a qualidade das imagens, dispensar a necessidade de colaboradores externos, minimizar o tempo gasto para o registro, reduzir o custo, minimizar os riscos de infecção e assegurar o fiel registro fotográfico dos procedimentos (37).

O uso de protetores aquáticos de policarbonato, produzidos especificamente para cada tipo de câmera, esterilizados foi descrito por Graca-Rabasco e colaboradores com a finalidade de reduzir custos e tempo de cirurgia. Esses protetores são esterilizados à frio, como em gás peróxido de hidrogênio. A câmera é utilizada com qualquer outro material cirúrgico, fazendo parte da mesa de instrumental e podendo ser levada ao campo cirúrgico (33).

Diferentes relatos de uso da câmera portátil GoPro® (Woodman Labs, Half-Moon Bay, California, USA) estão presentes na literatura (32,39–43). Sandri et al faz um breve relato do uso de câmera GoPro Hero 2® para montadas na cabeça do cirurgião para gravação dos médicos em treinamento (44). Bizzoto sugere configurações de uso para GoPro® como uso de luzes não cialíticas, modo de visão estreito da câmera, resolução de 1080p e 30 FPS (40).

Nair e colaboradores adaptaram uma câmera tipo GoPro® para cirurgias periorbitais. Salienta que o uso da câmera não traz nenhuma dificuldade para o uso concomitante de lupas cirúrgicas. O disparo das fotografias é feito pela enfermeira assistente atrás de um dispositivo portátil conectado sem fios com a câmera (45).

Modificações na lente da câmera, usando lente de 8,5mm f/3.2 com filtro pra raios infravermelhos auxiliam em um melhor ajuste da distância focal na posição de trabalho (42).

O uso da GoPro® na sala de cirurgia possui limitações. Fotos superexpostas devido a posição da cabeça, ângulo e intensidade de iluminação cialítica e posição das extremidades são um problema frequentemente encontrado. A meia-vida da bateria varia de acordo com qualidade da fotografia ou filmagem e em média fica em torno de uma hora e meia, o que pode ser curto para alguns procedimentos (32).

Além do uso acoplada na cabeça do cirurgião, a câmera GoPro® pode ser usada acoplada ao foco cirúrgico, por ventosas ou garras, e ligada a um monitor externo via cabo HDMI (*high-definition multimedia interface*) para facilitar o uso pelo cirurgião e a visualização imediata das imagens. Nesse caso também é sugerido uma adaptação da lente para uma de 25mm para magnificação. Tal sistema de fotografia proposto tem um custo de aproximadamente 600 dólares americanos (43).

O dispositivo da Google chamado de Glass® foi introduzido em 2013 em uma edição limitada de 8.000 aparelhos a um custo de 1.500 dólares americanos. Ele possui uma câmera de 5 megapixel para fotografia e grava vídeos em 720p (41). O dispositivo foi disponibilizado para grupos com interesse para utilização em pesquisa (38). Diferentes projetos utilizando o Glass® em cirurgias foram colocados em prática, alguns com uso isolado e outros em comparação com outros dispositivos, especialmente a câmera GoPro® (38,39,41).

Alguns pontos levantados pelos pesquisadores foi a baixa qualidade das fotos devido as condições de iluminação a dificuldade de posicionamento da cabeça fotografia (posição da cabeça frequentemente não acompanha a posição dos olhos), curta duração da bateria em filmagens e a impossibilidade do uso concomitante de lupa cirúrgica (38,39,41).

Quando comparados os dispositivos do Google Glass® e GoPro®, Paro e colaboradores chegaram à conclusão que a GoPro® apresenta uma qualidade melhor de imagem e duração da bateria, com maiores possiblidades de controle de imagem e exposição. O Google Glass®, por outro lado, se mostrou mais confortável e leve para uso durante o procedimento (41).

Dentre todas publicações sobre o tema, certamente o trabalho desenvolvido por Gaujoux e colaboradores merece destaque. No estudo, os autores compararam três tipos diferentes de câmeras usadas no registro de fotografias intraoperatórias em modelo experimental: câmera de um celular (iPhone 4S®, Apple Inc, California); câmera intermediária estilo *bridge câmera* (Lumix DMC-FZ200®, Panasonic, Japan); e uma câmera profissional estilo SLR (EOS 5D mark II®, Canon, Japan, com lentes EF USM 85mm f/1.8), Canon. Os autores simularam o ambiente intraoperatório, e descrevem as condições de iluminação da sala cirúrgica produzidas pela luz fluorescente da sala; luz satélite focada no campo operatório com uma temperatura de cor de 3800 K através de LED (luz cialítica) ou flash (29).

Gaujoux et. al. avaliaram fotografias em um ambiente cirúrgico simulado e compararam a qualidade de imagem quanto alguns quesitos. A imagens foram registradas por um fotógrafo profissional. Seu estudo mostra grande potencial no auxílio no entendimento dos fenômenos que ocorrem no ambiente intraoperatório e submetidos à documentação fotográfica. A luz fluorescente fornecida na sala foi de 164 lux. As luzes cialíticas do foco cirúrgico forneceram 21920 lux – mais de cem vezes mais intensa que a luz ambiente (29).

Das conclusões obtidas, os autores propuseram algumas recomendações para configuração da fotografia intraoperatória, dentre as quais se destacam: sujeito sempre centralizado na foto, distância do objeto de 75cm para lente de 80 e 100mm, preferir zoom óptico, evitar flash, usar luz cialítica, balanço de cor manual sempre que possível, evitar superfícies molhadas no campo, incluir marcos anatômicos no enquadramento, ISO menor que 400, velocidade do obturador maio 1/100s e abertura do diafragma pequena (menor f/8) (29).

3.7 ESPECIFICAÇÕES DAS CÂMERAS FOTOGRÁFICAS ESTUDADAS

CÂMERA DO TELEFONE CELULAR

Para representar os equipamentos com a câmera do celular foi utilizado o modelo Samsung Galaxy S7®. Possui sensor dual pixel de 12 megapixels, lente de 26 mm e resolução de 4290 x 2800 pixels.

CÂMERA POINT & SHOOT AUTOMÁTICA

Para representar as fotografias com câmeras comuns (Point & Shoot) foi utilizada a Canon PowerShot A640®. Ela possui um sensor CCD, 10 megapixels, 7.18mm por 5.32 mm. Lente de 7.3-29.2mm.

A profundidade focal da lente é de 35 a 140mm. A faixa de abertura vai de f/2.8 a f/4.1. Resolução de 3648 x 2736 pixels. As configurações foram deixadas em modo automático

CÂMERA POINT & SHOOT MANUAL:

Para representar as fotografias com câmeras comuns (Point & Shoot) foi utilizada a Canon PowerShot A640®. Ela possui um sensor CCD, 10 megapixels, 7.18mm por 5.32 mm. Lente de 7.3-29.2mm.

A câmera Point & Shoot com configurações manuais, realizadas por um fotografo profissional, e personalizadas para o ambiente cirúrgico durante estudo piloto prévio.

As configurações foram abertura de 4, tempo de exposição 1/400, ISO 200, distância focal 7,3mm, f/4.

CÂMERA PROFISSIONAL:

Para representar as câmeras DSLR foi utilizada a Sony DSLR-A230® com lentes 18-55mm / F3.5-5.6. Possui sensor CCD de 23,6 x 15,8 mm de 10.2 megapixels. As configurações foram deixadas em modo automático.

4. JUSTIFICATIVA

A fotografia intraoperatória é extremamente importante no meio médico, pois registra um momento único, que não poderá mais ser repetido. A sala de cirurgia torna-se um ambiente adverso à fotografia devido às condições distintas de iluminação, ao dinamismo do processo cirúrgico, às restrições do ambiente estéril e ao enquadramento fotográfico dinâmico. Estas dificuldades impactam de maneira negativa a qualidade da documentação fotográfica. Não há até o presenta momento uma técnica padrão-ouro para o registro de imagens.

Neste sentido, justifica-se o desenvolvimento do trabalho com a finalidade de avaliar qual o melhor método para obter essas fotografias com a maior qualidade.

5. OBJETIVOS

5.1 OBJETIVO GERAL

Analisar a qualidade da fotografia com diferentes tipos de máquinas fotográficas sob luz ambiente e do foco cirúrgico.

5.2 OBJETIVO ESPECÍFICO

- Comparar o conceito geral e mediana das fotografias capturadas com quatro tipos de câmera (câmera do telefone celular, câmera tipo *point & shoot* em modo automático, câmera tipo *point & shoot* em modo manual e câmera profissional DSLR em modo automático) sob a luz do foco cirúrgico;

- Comparar o conceito geral e mediana das fotografias capturadas com quatro tipos de câmera (câmera do telefone celular, câmera tipo *point & shoot* em modo automático, câmera tipo *point & shoot* em modo manual e câmera profissional DSLR em modo automático) sob a luz do foco cirúrgico;

- Comparar o conceito geral e mediana das fotografias capturadas com três tipos de câmeras diferentes (câmera do telefone celular, câmera tipo *point & shoot* em modo automático e câmera profissional DSLR em modo automático) sob a luz ambiente;

- Comparar a qualidade da fotografia capturada com cada câmera (câmera do telefone celular, câmera tipo *point & shoot* em modo automático, câmera tipo *point & shoot* em modo manual e câmera profissional DSLR em modo automático) quanto a quesitos pré-determinados de foco, exposição (subdivido em superexposição e subexposição), nitidez, profundidade de campo e granulação;

- Comparar a qualidade da fotografia capturada entre a luz ambiente e a luz do foc cirúrgico dentro de cada uma das três câmeras (câmera do telefone celular, câmera tipo *point & shoot* em modo automático e câmera profissional DSLR em modo automático .

6. ARTIGO MANUSCRITO

TITLE PAGE

"COMPARISON BETWEEN INTRAOPERATIVE PHOTOGRAPHIC RECORDING METHODS"

Author list: Francisco Carlos dos Santos Neto, MD[1], Milton Paulo de Oliveira, MD[2], Sérgio Luís Amantéa, MD[3]

1. Francisco Carlos dos Santos Neto, MD. Universidade Federal de Ciências da Saúde de Porto Alegre. Porto Alegre/RS. Brazil.
2. Milton Paulo de Oliveira, MD. Department of Plastic Surgery of Pontifícia Universidade Católica do Rio Grande do Sul (PUC/RS). Porto Alegre/RS. Brazil.
3. Sergio Luiz Amantéa. Universidade Federal de Ciências da Saúde de Porto Alegre. Porto Alegre/RS. Brazil.

Corresponding author:

Francisco Carlos dos Santos Neto, MD
Vidar Clínica Multidisciplinar
Rua Dr. Armando Odebrecht 70, sala 802
CEP 89020-403
Blumenau/ SC. Brazil
franciscosantosneto@me.com

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Not presented.

Short Running Head (no more than 40 characters in length): Comparison among different cameras, settings and lighting in operative field.

ARTICLE

COMPARISON BETWEEN INTRAOPERATIVE PHOTOGRAPHIC RECORDING METHODS

Santos Neto FC, Oliveira MP, Amantea SL

ABSTRACT

The intraoperative photographic record is still an unexplored subject within the medical literature, despite the great importance that these records have. Intraoperative photography and video serve a variety of functions, both teaching and legal. We propose the evaluation of different methods of intraoperative photographic recording in different lighting conditions.

Descriptive study comparing four types of photographic cameras in two lighting modalities within a surgical room. Photos were evaluated by specialists regarding quality photography requirements. For statistical analysis, the Mann-Whitney U test and the Kruskal-Wallis test were used to compare the groups. Values for $p \leq 0.05$ were considered statistically significant.

Overall, there was a difference between the camera scores ($p < 0.001$). Point & shoot auto mode and professional cameras, point & shoot auto mode and cellphone cameras and professional and cell phone cameras had the same median. The highlight may be that the cell phone camera had a median (average place order) of the test a little higher compared to all other cameras. The main difference is that the point & shoot manual mode presented a lower score than the other three cameras ($p < 0.001$).

By the present study, we can also infer that there is no difference in making photographs with professional cameras, common cameras or the cellphone cameras

when they are configured in automatic mode. Using a cell phone to register photos can be a practical, financially acceptable alternative, without the need for specialized personnel to configure and manipulate it and maintaining quality in the photographic records.

INTRODUCTION

Medical photography has existed for about 150 years, when Alfred Donne produced the first images applied to the activity.[1] Since then, the photographic documentation in surgery is of fundamental importance for its good practice and arouses interest in several moments of the operative act.[1]

Preoperative photography is useful as a reference point of the case, as a coadjuvant in clinical examination, as an aid in surgical planning and in the conduction of surgery in an operating room. Postoperative photography is used for educational purposes, research, documentary medical records and legal justification.[2] However, the intraoperative photographic documentation has different characteristics from the others mentioned above. It has the opportunity to demonstrate a dynamic series of unique events inherent to the surgery in an operating room. In this way, the intraoperative photographic documentation allows the documentation of the procedure, assists in the education of surgeons in training and specialists, subsidizes research and also contributes to individual technical improvement.[2] The digital age made it possible for surgeons to access skilled photographic equipment and to have a higher capacity for storing high quality images. [2]

However, in the operating room there are environmental conditions that are not found in a photographic setting linked to the medical practice.[3] The need to adapt to the different lighting conditions, the dynamic of the surgical process, the restrictions imposed by the sterile environment and the obstacles in the photographic framing produce difficulties that negatively impact both, the operative time and the asepsis conditions, as well as the very quality of photographic documentation.[3,4]

Photographic medical documentation requires clean, unchanged images, fitting as closely as possible to reality. Frequently, it portrays a single and unique event, so they must be recorded with the highest precision and accuracy, within a standardized technique.[5] Despite its importance, the intraoperative photographic record is still little explored within the medical literature. A recent systematic review by Gaujoux et al. identified only five articles with relevant results on the topic.[6]

Systematic recording of photographs during surgical procedures brings benefits both to the patient and surgeon. In addition, allowing a review of the surgical steps it is possible to compare outcomes resulting from the act.[6]

Adverse lighting conditions, which can reach more than 100,000 Lux below the surgical focus, is one of the major adversities imposed for the photographic record.[7] Some institutions may have their own specialized video and photo services. However, they are expensive and result in the presence of more people in the operating room, a traffic that can compromise the standards of asepsis and sterility. In addition, the photographer often works with a limited view of the procedure, whether due to the position of the surgeon or the need to avoid contamination of the surgical field.[8] An intraoperative field photographer must be adapted to the surgical environment, have notions of the procedure performed and the anatomy pertinent to the case.[6]

Therefore, we delineated a study with the objective of evaluating different methods of photographic registration made by the surgeon in a simulated intraoperative field under different lighting conditions.

METHODOLOGY:

Design and Field of Study

The research was developed in the operating theater of the Hospital da Criança Santo Antônio (Santo Antônio Children's Hospital), part of the Hospital Complex of the Santa Casa de Misericórdia of Porto Alegre, in Porto Alegre, Brazil. The study was structured in a prospective and controlled way, with simulated model interventions.

The surgical room in which the experiment was conducted measured approximately $30m^2$ and had direct and indirect artificial lighting. It was part of a set of six operating rooms in the referred hospital. The phases of experimentation were planned in advance and the operating room had its use blocked, in the shift of the activity, to be exclusively dedicated to the interests of the research.

Identification of models and photographic record

Six dolls with different color and texture patterns were selected to be used in photographs in the operating room environment, with a surgical table and operative fields under lighting conditions similar to those used in surgical procedures.

Each of the six models was photographed by four different types of cameras in different positions (fontal and profile), focal distance (focused and panoramic) and lighting conditions (with ambient light and surgical focus). The cameras have been selected to represent the main devices available on the market: a Canon ® point & shoot camera (Powershot A640 model), a Samsung SM-G930F cell phone camera (model S7) and a professional DSLR Sony DSLR A230 camera. In addition, the Canon® Powershot A640 model was manually adjusted (manual mode) by a specialist in photography to perform photographic recording under the surgical focus. The manual configurations were: aperture 4, exposure 1/400, ISO 200, focal length 7,3mm, f/4.

All photographs were taken by a single plastic surgeon with experience in acquiring intraoperative field images for his individual records. The photographs were taken in the same surgical environment under the two lighting conditions. At the end, each camera on automatic mode has taken 48 shots and the camera on manual has taken 24 shots, totaling 168 photos.

<u>Lighting conditions:</u>

The photographs were taken under two different lighting conditions. All four cameras recorded the photographs with the illumination of the surgical focus. Under ambient light, the camera with fixed setting manually adjusted was not used.

A lux meter measured the intensity of light at the place where the dolls were positioned. In the light under the surgical focus, the calibration was 132,482 LUX and under the ambient light, the calibration was 235 LUX. (Fig. 1)

Fig. 1: Distribution of the ambient light of the operating room and the surgical focus.

<u>Photo quality evaluation:</u>

All photographs were randomized and renamed to sequence numbers, following a randomization process with a specific computer application (www.randomization.com).

The photographs were submitted for expert photographic evaluation. The evaluator was blinded and it was not possible to identify which photograph belonged to each camera. The specialist evaluated the quality of the photographs and assigned grades from one to five for each requirement: framing, focus, exposure (subdivided into superexposed and underexposed), sharpness, depth of field and granulation.

For each photo, the question "Looking at the photograph as a whole, what is the concept you would attribute to it?" were answered. This score was compared with the median of the other items to verify the consistency of the evaluator. All photos were evaluated on the same high-resolution monitor and in compressed JPEG format.

Statistical analysis:

A descriptive analysis was performed with frequency distribution analysis (mean and standard deviation, median and interquartile 25-75 and minimum and maximum values). The Kolmogorov-Smirnov test was used to test the hypothesis of adherence to the normal distribution. For comparison of non-parametric data, the Mann-Whitney U test and the Kruskal-Wallis test were used to compare the median between four independent groups (between cameras). Statistically significant values were considered for all analyzes, $p < 0.05$. The analyzes were processed in the statistical software SPSS for Windows in its version 22.0.

RESULTS

A total of 168 photographs were recorded, considering exposure in different lighting scenarios. Table 1 shows a detail of the distribution of the number of photos taken per camera individually and the lighting scenario used.

Table 1: Distribution of photo number by camera type and lighting condition.

Surgical Focus Light		Ambient light	
Cell Phone Camera	24 photos	Cell Phone Camera	24 photos
Point & Shoot Camera Auto Mode	24 photos	Point & Shoot Camera Auto Mode	24 photos
Professional camera	24 photos	Professional camera	24 photos
Point & Shoot Camera Manual Mode	24 photos	Point & Shoot Camera Manual Mode	No photos

The general median among the cameras was compared using the Kruskal Wallis test. Overall, there was a difference among camera scores ($p < 0.001$). To verify which cameras presented the highest attributes, a multiple comparison was performed. The main difference is that the Point & Shoot Camera Manual Mode presented lower photo quality compared to the other three cameras ($p < 0.001$). The Point & Shoot Camera Auto Mode and the cell phone camera had similar attributes ($p=0.648$). The cell phone and the professional cameras were also similar ($p = 0.181$). The Point & Shoot Camera Auto Mode and professional cameras were the ones that presented the highest similarity of comparison ($p=1,000$).

In figure 2, the graphical representation of the individual attributes of each camera in a comparative way was shown. The observed difference was centered only on the camera configured manually, with fixed standards.

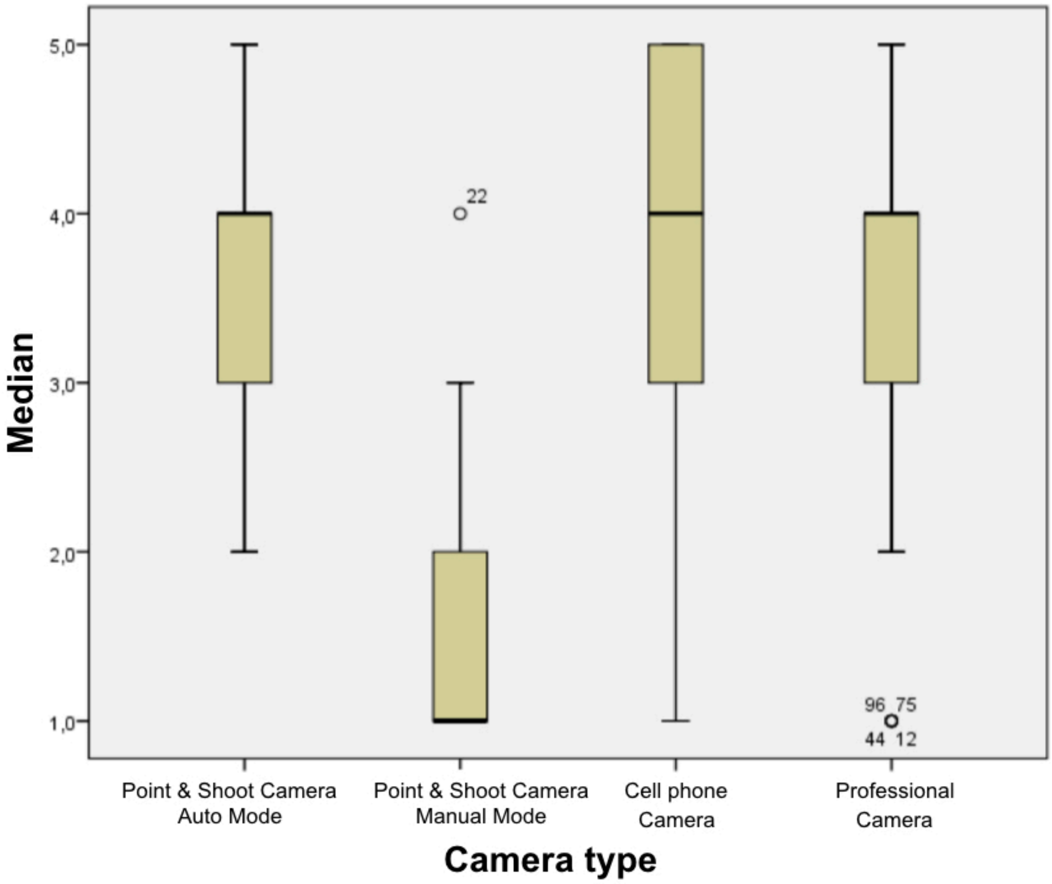

Figure 2: Box-plot with individual attributes (medians) of the different cameras.

An analysis was also carried out by individual requisites, that is, the areas of evaluation of the specialist considered for analysis of the quality of records. For the framing, the cameras with the highest attributes were the cell phone and the point & shoot cameras, with no difference between them against this attribute (p=0.936). The point & shoot cameras presented better framing than the professional camera (p=0.003). In the same way as the cell phone camera, which showed a better framing compared to the professional camera (p <0.001).

For the other domains of evaluation: focus, overexposure, underexposure, sharpness, depth of field and granulation, there was no differences between the cell phone, point & shoot and professional cameras. Here, again, the point & shoot camera with manually adjusted settings presented lower performance compared to the other three devices (p <0.001).

Comparing light exposure to the surgical focus and ambient light (Table 2), was found statistically significant differences between the three devices evaluated: automatic point & shoot (p=0.004), cell phone (p<0.001) and professional (p<0.001). The photographic record in ambient light always presented higher attributes (better image quality). In this scenario, the manually configured camera could not be tested, because it is programmed with fixed parameters for photographic recording only with light exposure of the surgical focus.

Table 2: Comparison of medians (grades) between surgical focus and ambient light considering the same camera.

	Light	**No**	**Average places (order)**	**Mann-Whitney**	**Sig. (P)**
Point ‘n Shoot Auto Mode	Surgical focus	24	18.81		
	Ambient light	24	30.19	151.50	0.004
	Total	48			
Cell phone Camera	Surgical focus	24	16.81		
	Ambient light	24	32.19	103.50	<0.001
	Total	48			
Professional Camera	Surgical focus	24	17.42		
	Ambient light	24	31.58	118.00	<0.001
	Total	48			

Considering the luminous exposure of the surgical focus, the cell phone and the automatic point & shoot cameras presented higher attributes, without statistically significant differences between them. The manually configured camera presented lower attributes when compared to the other three cameras ($p<0.001$) - Table 3.

For an exposure to ambient light, the cell phone camera was the device with the highest attributes when compared to Canon ($p<0.02$) and Sony ($p<0.03$) cameras.

Table 3: Comparison of medians (grades) between the cameras considering surgical focus and ambient light.

	Camera	**No**	**Average places (order)**	**Kruskal Wallis**	**Sig. (P)**
Surgical focus	Point & Shoot Camera Auto Mode	24	57.27	26.83	<0.001
	Cell phone camera	24	60.96		
	Professional camera	24	51.27		
	Point & Shoot Camera Manual Mode	24	24.50		
	Total	**96**			
Ambient light	Point & Shoot Auto	24	31.38	8.7	0.012
	Cell phone camera	24	45.98		
	Professional camera	24	32.15		
	Total	**72**			

Comparing the surgical focus with ambient light, the median on all cameras was better at ambient light. All attributes, when compared individually, had better evaluations with ambient light ($p<0.01$), except for the framing, in which there was no change.

DISCUSSION

It is possible to obtain an intraoperative field record using different devices. The images generated with automatic adjustment devices seem to have the preference of the users when compared to the devices with manually adjusted settings. However, recording the desired image in the intraoperative field does not guarantee quality and similarity among the most frequently used equipment.

Luminous exposure to surgical focus continues to be an important impediment to record quality. All images generated in ambient light, regardless of the device used, presented better photographic quality when compared to the influence of exposure through the surgical focus. By the technological evolution of these devices, manual adjustments establishing fixed configurations do not seem to add any benefit to the quality of the photo, since they presented an evaluation with smaller global attributes in all the questions compared in our study. This may be due to the variation of positions of the models or the incidence of the surgical focus in different photos. It is possible that the camera needs a new configuration on the manual settings for each photography, which may be not possible in these circumstances.

In a scenario of exposure to ambient light, cell phones seem to present greater attributes to the quality of the photo, without considering other potential benefits related to practicality, portability and cost.

Although there were reports in the literature addressing methods and proposals for systematization of intraoperative photographs, these have been based at the expense of individual experiences and opinions, with a small number of patients and without the appropriate methodology.[3,9–15]

More recently, some initiatives have been proposed to evaluate the GoPro portable camera (WoodmanLabs, Half-MoonBay, California, USA)[8,13–18] and the Google device called Glass.[12,13,15] Some points have been stressed by the researchers when using such devices equipped with more modern technology. The photos are of poor quality due to lighting conditions, difficulties in positioning the head at the time of photographic recording (head position often does not match the position of the eyes), short battery life while shooting and the impossibility of concomitant use of surgical loupes.[12,13,15] Thus, such devices do not seem to add benefits to conventional image acquisition techniques.

More elaborate devices, adapting the imaging unit near the surgical field and remote starting by varied commands, are found in sporadic reports and are still far from being considered a solution.[19] [19]

Humphrey and colleagues suggest the use of a professional machine with individually configured settings. They suggest the focus must be done manually, so the surgeon can decide on the highlighted object, and not the machine. Aperture of the diaphragm between f22 and f32 would maintain a depth of field suitable for intraoperative photographs.[3] The manually configured camera on the present study did not perform better than the other devices. Critical analyses of the data highlight the fact that the luminance of the surgical room evaluated by Humphrey was 21,920 lux and, in the present study, was 132,000 lux. This overexposure of light was an important factor to difficult the adjust of the equipment correctly, both in manual and automatic mode.

Despite the importance of the intraoperative photographic record, there is not an ideal standard or a systematized technique considered unequivocally superior. Gaujoux and colleagues demonstrated the lack of data through a systematic review (last 10 years - Medline via PubMed) using the following search strategy for MESH and non-MESH terms: (picture OR photography) AND (clinical OR surgery OR intraoperative) AND (guide OR guideline). After reviewing the abstracts, only those related to intraoperative photography were selected. Of 1029 articles obtained by the research, after the inclusion of the selection criteria there were only five left.[6]

The present data do not show differences in the quality of photographs between an ordinary camera, a professional camera and a cell phone camera, despite some recommendations against the use of cell phone cameras or other favorable to the use of professional devices.[6,20]

The professional camera seems to be harder to frame the pictures. This is probably related to the fact that the LCD screen present in the cell phone and point & shoot camera facilitated the framing. Looking direct into the viewfinder made the framing harder due to the perpendicular positioning the object and the distance needed.

When considering the lighting conditions, whit exception of framing, all cameras performed better in the evaluated items under the ambient light. This may suggest that, whenever possible the surgical focus may be turned off to register the photography.

Of all the devices evaluated individually, the cell phone camera presented greater ease of framing. This can be related to the size of the equipment and screen, facilitating the framing even in adverse positions, which if added to other characteristics (portability, access, cost) can make this device an interesting alternative for intraoperative registration, mainly outside exposure to the lighting of the surgical focus.

In this regard, to obtain better quality photographs, turning off the surgical focus at the time of photographic registration improves the evaluation of image related issues such as exposure, sharpness, depth of field and granulation.

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7. CONCLUSÃO

Podemos inferir com os dados do presente estudo que, em termos de qualidade geral da fotografia, entre as câmeras estudadas, a câmera point & shoot configurda manualmente apresentou o pior desempenho, sendo o desempenho das demais câmeras, semelhante.

Quando analisados os quesitos invidualmente, a câmera DSLR parece apresentar maior dificuldade de enquadramento do campo estudado. Nos demais queistos (foco, exposição, nitidez, profundidade de campo e granulação), a câmera Point & Shoot configurada manualmente apresentou as piores avaliações.

Comparando as diferentes condições de iluminação, conclui-se que fotografar com a luz ambiente produz fotos de melhor qualidade que fotografar sob a luz do foco cirúrgico. Quando fotografado na luz do foco cirúrgico a câmero do telefone celular e câmera Point & Shoot no modo manual fizeram fotos melhor. Na luz ambiente, a câmera do celular teve foto mais bem avaliadas.

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9. ANEXOS

9.1 ANEXO 1: NORMAS PARA SUBMISSÃO NO PERIÓDICO

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All manuscripts amenable to Level of Evidence grading will be assessed and have a clinical question and LOE grade assigned by a special, independent panel at the American Society of Plastic Surgeons headquarters. We **no longer request** that you provide an initial indication of clinical question or level of evidence. **The final Level of Evidence grade for accepted papers will be determined and assigned by the independent panel of Level of Evidence experts.**

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- Review articles
- Instructional course lectures
- CME courses
- Editorials
- Correspondence

As far as what is or is not ratable, the standard is to exclude basic science, bench work, and animal studies because the information gained from these studies is not something that can be applied directly to patient treatment decisions. See the article **"The Level of Evidence Pyramid: Indicating Levels of Evidence in *PRS*Articles"** in the July 2011 issue of *Plastic and Reconstructive Surgery* for more information.

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American Society of Plastic Surgeons Rating Levels of Evidence and Grading Recommendations

Evidence Rating Scale for Therapeutic Studies

Level of Evidence	**Qualifying Studies**
I	High-quality, multicenter or single-center randomized controlled trial with adequate power; or systematic review of these studies
II	Lesser-quality randomized controlled trial; prospective cohort study; or systematic review of randomized controlled trials
III	Retrospective cohort or comparative study; or case-control study
IV	Case series with pre/post test or only post test
V	Expert opinion developed via consensus process; case report or clinical example; or evidence based on physiology, bench research, or "first principles"

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I	High-quality, multicenter or single-center cohort study validating a diagnostic test (with "gold" standard as reference) in a series of consecutive patients

II	Exploratory cohort study developing diagnostic criteria (with "gold" standard as reference) in a series of consecutive patients
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Level of Evidence	**Qualifying Studies**
I	High-quality, multicenter or single-center prospective cohort or comparative study with adequate power
II	Lesser-quality prospective cohort or comparative study; retrospective cohort or comparative study; or untreated controls from a randomized controlled trial
III	Case-control study
IV	Case series with pre/post test or only post test
V	Expert opinion developed via consensus process; case report or clinical example; or evidence based on physiology, bench research, or "first principles"

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The **body of the text** must conform to acceptable English usage and syntax; the contents must be clear, accurate, coherent, and logical. Avoid using abbreviations unless they are so common that they are never spelled out. The *Journal* aims for optimal readability.

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We can allow only approximately 4 weeks for a Discussion to complete the manuscript. If you are unable to finish within that time, please contact the Editorial Office.

CLINICAL FOLLOW-UP ARTICLES

Authors of Clinical Follow-Up articles should follow the general format and instructions provided in the Instructions for Authors.

Please bear in mind that your manuscript should be of approximately 500 to 1000 words in length to bring the readership up to date on your current experience with the procedure that you previously described. These articles are intended to be an update only, not an original article.

POLICY ON SOCIETY HISTORY ARTICLES

1. All listed groups for which PRS is the official Journal and select unlisted partnering groups/meetings will be allowed to submit for peer review and ultimately publish One Society-specific History article every 10 years. The history articles should meet the criteria of a PRS Special Topic article and are subject to peer review.

2. Listed groups can continue to publish their society-specific Abstract Supplements as per existing protocols, with requisite publication costs in PRS or PRS Global Open.

3. Paid-for Society-Specific History Supplements will be considered on a case-by-case basis.

ADDITIONAL INSTRUCTIONS FOR REFERENCES

The style for **references** follows the AMA (American Medical Association) Citation Style. Many resources exist in word processing programs and online to help format to the **AMA Manual of Style**.

A few basic examples follow:

Journal Articles

1. Craft AB. Title with initial cap in Roman: Subtitle also with initial cap in

Roman. *Plast Reconstr Surg*. 1997;100:111-115.

[List all authors to a maximum of six. If there are more than six, list three et al.]

Chapter in a Book

2. Reagan MF. Title with initial cap: Subtitle with initial cap. In: Smith SR, Jones HG, Green TM, eds. *Cap and Lower Case Title in Italics*. Vol. 5, 5th ed. New York: Bender & Sons; 1971:22-50.

Entire Book

3. Wayne JD, ed. *Cap and Lower Case Title in Italics.* Basel, Switzerland: Rodan-Smythe; 1971.

Proceedings

4. Ames G. Title with initial cap only in Roman. In *Proceedings of the 5th Annual Meeting of the Society of American Chemists,* Boston, Mass; June 4-9, 1996.

Presentation

5. Ames G. Title with initial cap only in Roman. Paper presented at: 2007 Annual Meeting of the American Society of Plastic Surgeons; October 30, 2007; Chicago, Ill.

World Wide Web

6. American Society of Plastic Surgeons. 2005 liposuction statistics. Available at: **http://asps.org/stats.htm**. Accessed March 4, 2015.

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