



Towards an intelligent medical system for the aesthetic evaluation of breast cancer conservative treatment

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KEYWORDS

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Support vector machines

Summary

Objective: This work presents a novel approach for the automated prediction of the aesthetic result of breast cancer conservative treatment (BCCT). Cosmetic assessment plays a major role in the study of BCCT. Objective assessment methods are being preferred to overcome the drawbacks of subjective evaluation.

Methodology: The problem is addressed as a pattern recognition task. A dataset of images of patients was classified in four classes (*excellent*, *good*, *fair*, *poor*) by a panel of international experts, providing a gold standard classification. As possible types of objective features we considered those already identified by domain experts as relevant to the aesthetic evaluation of the surgical procedure, namely those assessing breast asymmetry, skin colour difference and scar visibility. A classifier based on support vector machines was developed from objective features extracted from the reference dataset.

Results: A correct classification rate of about 70% was obtained when categorizing a set of unseen images into the aforementioned four classes. This accuracy is comparable with the result of the best evaluator from the panel of experts.

Conclusion: The results obtained are rather encouraging and the developed tool could be very helpful in assuring objective assessment of the aesthetic outcome of BCCT.

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1. Introduction

Breast cancer conservative treatment has been increasingly used over the last few years, as a consequence of its more acceptable cosmetic outcome when compared with mastectomy, but with identical oncological results. Although considerable research has been put into BCCT techniques, diverse aesthetic results are common, highlighting the importance of this evaluation in institutions performing breast cancer treatment, so as to improve working practices.

The categorization of the aesthetical result relies on the complex interplay of various factors, subjectively estimated and combined by observers through visual inspection. Traditionally, aesthetic evaluation has been performed subjectively by one or more observers [1–3]. The accurate evaluation of aesthetic result is mainly dependent on the observers' experience because different and complementary variables and estimations are combined synergistically in assigning an evaluation grade. Taking into account the inherent subjectivity of any human decision, the final evaluation of aesthetic result performed by observers is questionable. In fact, this form of assessment has been shown to be poorly reproducible [4–7], which creates uncertainty when comparing results between studies. It has also been demonstrated that observers with different backgrounds evaluate cases in different ways [8].

Objective methods of evaluation have emerged as a way to overcome the poor reproducibility of subjective assessment and have until now consisted of measurements between identifiable points on patient photographs [4,7,9]. The correlation of objective measurements with subjective overall evaluation has been reported by several authors [5–7,10]. Until now though, the overall cosmetic outcome was simply the sum of the individual scores of subjective and objective individual indices [5,6,10,11].

The present study introduces a new methodology for assisting the aesthetical evaluation of BCCT, based on an optimized objective score for the quantification of the aesthetic results. The proposed method lies in the cross-section of medical expert systems, soft computing and machine learning. The method discriminates among the four categories of the best-known classification.

This introduction is concluded with a brief review of the work done in this area. In the next section we describe the data used and the procedure followed to obtain a gold standard classification. Section 3 outlines the analysis techniques employed. Section 4 presents the results of the experimental

investigations. Finally, conclusions of the work are given in the last section.

1.1. Brief history of the cosmetic assessment measures

Harris [1] introduced a subjective overall cosmetic score, that would later become a de facto standard: *excellent* (treated breast nearly identical to untreated breast), *good* (treated breast slightly different than untreated), *fair* (treated breast clearly different from untreated but not seriously distorted) and *poor* (treated breast seriously distorted).

Until Pezner [4], the reported works – of which [12,13] are examples – have focused on the correlation between the overall cosmetic result, the effects of the surgery and the technique used, with the assessment being subjectively performed by observers. With Pezner [4] the objective assessment of the cosmetic result of the surgery was introduced with the first objective measure to evaluate asymmetry, one of the aspects of cosmesis: breast retraction assessment (BRA). In Pezner [14] the importance of objective measures was reinforced by demonstrating that observer consensus of cosmetic outcome is difficult to obtain. The same line of action had followers in Limbergen [9], Tsouskas [15] and Vrieling [16], among others.

Noguchi [11] measured the breasts' asymmetry objectively with a Moire topography camera. Breast atrophy, skin change, and surgical scar were assessed subjectively by observers. The overall cosmetic outcome was the sum of the individual scores of the objective and subjective assessments, this way introducing the roots for an overall objective assessment.

Al-Ghazal [10,17] correlates the overall subjective evaluation performed by a six-member panel and the patients themselves, with an overall "objective" assessment, taking into account the objective measures of breast retraction and nipple deviation, and subjective factors (skin atrophy, skin changes, such as telangectasia or oedema, and surgical scar), analogously to Noguchi [11]. Yet using the same reasoning, Krishnan [18] added four individual rating (difference in volume, breast asymmetry, fibrosis and telangiectasia) to create an overall cosmetic index.

From this quick snapshot of what has been proposed so far, it is easy to conclude that current objective assessment evaluation methods lack a general and consistent approach. Our work aims at a totally objective overall measure, based on a more principled approach, rather than just the sum of the individual indices.

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