Introduction

More than 40% of the world’s population suffer from untreated tooth decay that requires therapy [1]. In cases of caries, patients receive suitable treatment, for example direct fillings or indirect restorations such as inlays or crowns. Today, treatment with ceramic or composite tooth-coloured inlays is regarded as a routine procedure. Failures in ceramic restorations were related to fractures/chipping (4%), followed by endodontic complications (3%), secondary caries (1%), debonding (1%), and severe marginal staining (0%). Odds ratios (95% confidence intervals) were 0.19 (0.04 to 0.96) and 0.54 (0.17 to 1.69) for pulp vitality and type of tooth involved (premolars vs. molars), respectively [2]. However, almost a third of these require further treatment within four years (“reentry”) for example a partial repair or a new restoration. Adverse events (AEs) such as diverse technical problems, pain or even the failure or loss (SAE serious adverse event) of a restoration may occur [3]. It is therefore no surprise that dentists and patients spend the majority of their time (more than 60%) with the application, restoration and replacement of restorations [4]. The literature makes clear that as early as the diagnostic process occurs, a structured approach can allow a more complete technical and clinical assessment, and thus be a solution to the problems described [5–10]. In the conventional approach (gold standard), parameters such as border seal, proximal contact strength, shape, surface smoothness and accuracy of fit (by means of an inside impression) are assessed [11]. Structured guidelines for assessment are seldom found [12]. If it is already possible during reporting to identify the above weaknesses, then the incidence of a re-entry, and with it of AEs and SAEs, could be lowered. Within structured reporting guidelines it is significant easier to provide relevant contents and indications as effectively as possible. In addition, structured reporting with its clear sequence facilitates the clinical findings themselves. A number of concepts are subsumed under the term structured reporting, including the implementation of checklists and criteria [5,6]. In 2010, the World Dental Federation (FDI) revised the clinical criteria for the assessment of direct (fillings) and indirect (inlays, crowns) dental restorations and provided, amongst other things, the
possibility of training in the area of clinical decisionmaking [13]. In this way, the achievement of those learning objectives explicitly referred to in both National Competency-based Learning Objectives Catalogues in Medicine (NKLM) and in Dentistry (NKLZ) can be taken into account – that students should learn patient consultation from the viewpoint of (dental) medical concerns and have to implement decision making appropriate to dentistry [14,15].

Several areas of medical training are devoted to the problem described above, however, terms such as clinical decision-making or structured reporting have seldom made the move into the teaching of dentistry [16–18]. In a recent short Pubmed investigation, the keywords “clinical reasoning AND dental AND structured reporting” revealed no hits (state of search: 26.02.2019). In the light of this, the aim of the present study was to discover what influence structured reporting in accordance to FDI-standards (study group = A) of tooth-colored labfabricated restorations has on clinical decision-making. By way of comparison, the conventional approach in the form of short reporting (control group = B) was used as a gold standard.

Materials and Methods

Investigation period and setting

The experimental setting includes the data from a total of two clinical cohorts from each respective sixth semester of Dentistry. The period of investigation ran from the beginning of the winter semester 2014/2015 to the end of the summer semester 2015.

Study participants

Study participants were students of dentistry at the Dental University Institute of the Carolinum Foundation in Frankfurt on Main; they were enrolled in the first clinical course of conservative dentistry. The overall population consisted of 80 students, of which 31 were from the winter semester 2014/15 and 49 from the summer semester 2015.

Implementation

The course of the study is shown in figure 1. During the first clinical semester (6th semester) preparations for performing an indirect restoration (inlay) are carried out on extracted human teeth, after the theoretical principles for this have first been taught (duration of instruction 4 x 60 minutes). In the study population, 65 preparations on human teeth occurred in a simulation model. The preparation and the following restorations (65 composite inlays and 65 ceramic inlays) were produced based upon a prescribed SOP (standard operating procedure) protocol (Figure 2). For the treatment of each tooth, both a composite and a ceramic inlay were available. Each student then assessed both inlays on the human simulation model using two different assessment sheets with (study group) and without (control group) modified specifications of the FDI (Figure 3). Prior to the assessments, in a one-hour session students received both theoretical and practical instruction in proper use.

In the study group, two scales (aesthetic and functional parameters) were used to assess structured findings, consisting of a total of 7 items each with 5 subgroups. In the control group, a shortened valuation variant was used, also consisting of 2 scales (aesthetic and functional characteristics) and 5 items that corresponded to conventional procedure (gold standard). In both reporting sheets, assessment was conducted on a scale from 1 (very good) to 5 (insufficient). Following the evaluation using the respective reporting sheets, the clinical decision was made for one of the two restorations. Here, students were offered the possibility of explaining in free text commentary how they had come to their respective clinical decision. For the assessment of the quality of the two methods of structured reporting, the sensitivity and the specificity confidence intervals (CI) and the respective predictive values (positive: PPV, negative NPV) were determined.

Statistics

Statistical analysis was carried out in cooperation with the Competence Centre for Exams in Medicine in Baden Württemberg, Medical Faculty, Heidelberg, Germany. All evaluations were carried out using the program R version 3.4.4, packet epiR version 0.9-93. Determination of sensitivity and specificity, as well as positive and negative predictive values was conducted using the asymptomatic chi² test. Significance was tested using the exact Fisher test.
Results

The study finally included n = 65 of 80 students. The initial drop-out rate of 15% (68 students) could be explained by the number of evaluation sheets not submitted. The second drop-out rate of 4.41% (65 students) resulted from the fact that the comments section on the evaluation sheets was not filled out, and thus those evaluations were not possible. The data were evaluated per protocol.

FDI-Reporting (study group)

By means of FDI reporting, a ceramic inlay is favored with a great degree of consistency in a clinical decision that is in 34 of 43 cases. In addition, FDI reporting is also well suited to the clinical preference (in 18 out of 22 cases) for non-ceramic alternative care (composite inlays). For the FDI reporting, a sensitivity of 67% (95% CI: 46%-83%) and a specificity of 89% (95% CI: 75%-97%) emerged. This resulted in a positive predictive value of 82% (95% CI: 60%-5%) and a negative predictive value of 79% (95% CI: 63%-90%).

Conventional short reporting (control group)

In conventional short reporting, a ceramic inlay is favored with a great degree of consistency in clinical judgement, namely in 35 out of 40 cases. In addition, this type of reporting is also well suited for the clinical preference (in 15 out of 18 cases) for a non-ceramic alternative solution (composite inlay). For short reporting this results in a sensitivity of 56% (95% CI: 35%-75%) and a specificity of 92% (95% CI: 79%–98%). The positive predictive value was 83% (95% CI: 59%–96%) and the negative predictive value was slightly below at 74% (95% CI: 60%–86%).

Comparison of both groups

When comparing the study group FDI reporting and the gold standards of the conventional short reporting, a ceramic inlay is frequently evaluated equally (42 out of 46 cases). In the case of non-ceramic restorations, the assessment of the reporting sheets also largely coincides, specifically in 14 out of 22 cases. This results in a sensitivity of 78% (95% CI: 52%-94%) with a specificity of 84% (95% CI: 71%-93%). A PPV of 64% (95% CI: 41%-83%) was calculated, and a NPV of 91% (95% CI: 79%-98%). In the statistical evaluation, no statistically significant difference could be seen between the two evaluation sheets (p = 0.813).

Ultimately a total of 65 inlays were seated in the human simulation models; in the case of 23 of these, a clinical decision disregarding the criteria catalogue was made (35%). If the clinical decision was different to the results of the evaluation sheets, this was explained in a number of ways: 12 times due to the margin fitting, 6 times due to the proximal contact and twice regarding surface texture. Other less common reasons (one mention each) were: the adhesive bond, contouring, anatomical form and the color. In these cases, the above points were assessed as being clinically so serious that a decision based purely on the metrical data was regarded as inadequate.

Discussion

The literature shows that structured findings often reveal fewer linguistic ambiguities than free text findings [7]. This is especially the case when predefined structured elements tested by experts are used. Such structured elements were also employed in the present study. In addition, structured reporting presentations encourage the reporting physician to arrange the relevant information in a logical, ordered sequence. In conclusion, structured reporting contains more
relevant information for the subject involved and is thus more complete [8]. These efforts at increasing the completeness of the findings lead to more reliability in clinical decision-making [9]. On the basis of this knowledge, reporting systems are increasingly used that are adapted to the clinical situation. Structured reporting would thus in principal allow for the parameters in question to be completely recorded, and in so doing allow more efficient reporting.

In 2015, Dobranowski presented varying levels of structured reporting [10]. Based on this, control group B (conventional criteria) of the present study can be positioned on level 4 and study group A, according to the FDI, on level 6. Thus the FDI reporting criteria (specified by the World Dental Federation) are subject to an internationally recognized system of evaluation that was created for use in studies as well as in the instruction of students [13]. A modification of the evaluation sheet used was that not all the criteria recommended by the FDI were integrated. The biological parameters were excluded, as the evaluation took place in a simulation situation on extracted teeth [13].

Comparable studies were able to establish similar sensitivities (78.6%) and specificities (85.9%) with the use of FDI criteria for the evaluation of restorations, as in the present study [19]. To qualify this, however, it has to be mentioned that the author group of Signori et al. evaluated photographs and not actual available restorations. Furthermore, the present findings can be used to determine the efficiency of a test method based on sensitivity and specificity. Guide values of around 160% for the sum of sensitivity and specificity were interpreted with an acceptable degree of efficiency in the literature [20]. In the present study, the sum for the study group is 156%, in the control group it is 148%, only slightly below the limit.

Through consideration of the assessed restorations, critical thinking and evaluation skills are encouraged. This is a considerable part of clinical decision making in everyday practice [16]. In addition, the clear guidelines for structured reporting enable students to recognize recurring patterns; this promotes the acquisition of professional experience and precise diagnosis [18]. In this way, it is possible to already identify weaknesses in the context of the reporting of indirect restorations in everyday situations, and the frequency of a re-entry can be lowered. The medium-term durability of restorations can thus be raised.

The present study should be looked at critically, as there are significant limitations. The size of the population is limited, attributable to the low number of dentistry students and the range of data. Students each assessed individual restorations by analogy with the treatment situation, so that no inter-rater reliability could be recorded. However, it was not the aim of this study to verify this, but rather to examine the applicability of the evaluation sheets and the resulting clinical decision-making.

The principle of the study can easily be applied to other situations. Not only indirect restorations can be assessed using the reporting forms, but direct care can also be evaluated. The FDI criteria are also designed for such purposes. In addition, they could be applied to clinical situations directly on patients, taking further parameters such as biological criteria into account (postoperative sensitivity and tooth vitality; recurrence of caries, erosion, abfraction; tooth integrity like enamel cracks, tooth fractures; periodontal response compared to a reference tooth; adjacent mucosa; oral and general health) [13]. There are other areas of medicine and dentistry conceivable, however, where structured reporting might be applied in order to improve judgement, for example when recording findings or assessing prosthetic dentures. The criteria used should in each case be adjusted accordingly.

Conclusion

Due to the higher efficiency and sensitivity at comparable specificity, structured reporting on level 6, according to FDI criteria for tooth-coloured, lab-fabricated restorations, appears recommendable in the context of clinical decision making. Consequently, it is a good resource for users in order to promote decision-making in quality assessment and thus improve the durability of restorations.

References

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