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Clinical Behavior of Self-Adhesive Composite Resin Restorations: Literature Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Self-adhesive flowable composite resins are relatively new formulations on the market. These materials do not require the prior application of the adhesive system and, at the same time, can promote a durable seal at the tooth-restoration interface. However, there is little clinical information about these materials. Therefore, this review aimed to gather information on the clinical behavior of these self-adhesive materials by conducting a bibliographic search from 2010 to February 2024 in the PubMed, Embase, Web of Science, Scopus, and Cochrane Central Register of Controlled Trials databases. Clinical follow-up studies of restorations performed with these materials were eligible for selection. The search terms used were "self-adhesive composite" or "self-adhesive flowable composite" where 14 complete articles were evaluated and 12 were selected. Only clinical follow-up

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studies of enamel and/or dentin restorations performed with self-adhesive resins were eligible for selection. This systematic review concluded that the self-adhesive flowable resin showed results comparable to those of the conventional flowable resin. However, studies have shown that for restorations in Class I and V cavities, self-adhesive flowable composite resin performed better than restorations in Class II cavities.

Keywords: Self-adhesive flowable composite resin; conventional flowable composite resin; clinical behavior; literature review.

1. INTRODUCTION

Composite resins have become the materials of choice for esthetic restorations in anterior and posterior teeth [1]. Today, there are a variety of types on the market, each with different characteristics and physical properties according to their composition.

However, restorative materials that are simpler to use and that save time are more convenient for dental offices. Thus, advances in research have as their main objective the simplification of the technique while trying to improve retention of restorations, minimize microleakage, and reduce post-operative sensitivity [2,3].

One of the recent advances in dentistry was the introduction of self-adhesive flowable composite resins, which are the combination of two functional groups: the single-step adhesive system and the flowable composite resin [2–4]. By incorporating the functional monomer glycerophosphate dimethacrylate (GPDM) into the chemical composition of composite resins, the steps of direct restorative procedures were simplified [5,6]. Based on the manufacturer's claims, this monomer exhibits acidic properties that condition enamel and dentin [7]. Chemically, it binds to the calcium of the tooth structure and has two methacrylate functional groups, which can copolymerize with other methacrylate monomers [7]. Therefore, the use of these composite resins results in a reduction in the clinical time required for their application, as well as a decrease in errors and technique sensitivity. In contrast, it has been reported that GPDM only “conditions” rather than “binds” to hydroxyapatite [8]. Still, based on previous studies, these composite resins show a modulus of elasticity, hardness [9], and degree of conversion [10] superior to other conventional flowable composite resins. Furthermore, these composites exhibited more hygroscopic expansion [11] and water absorption [12] compared to other flowable composites 150 days after water immersion.

Flowable composite resins, compared to conventional hybrid resins, have inferior mechanical properties due to their lower filler content [13]. However, for large cavity restorations, where it receives an occlusal load, the use of flowable resins is recommended only for cavity lining [1]. On the other hand, in conservative cavity restorations, where most of the occlusal forces are supported by the residual tooth structure, the use of flowable resins has been recommended [3,14]. Traditional flowable composites require the prior application of a dentin adhesive system, but the self-adhesive flowable composite eliminates this need, simplifying the restorative procedure [15].

However, there is little information about the clinical behavior of these restorative materials. Thus, this study aimed to gather information about the clinical performance of these self-adhesive restorative materials to assist professionals in choosing the most appropriate materials for different clinical situations.

2. MATERIALS AND METHODS

(i) Eligibility criteria: Articles published in English dating from 2010 to February 2024 were eligible for this review. Selected articles included the search terms in the title or abstract. Full-text articles and literature reviews were chosen. Only clinical follow-up studies of restorations performed with self-adhesive resins were eligible for selection.

(ii) Data Sources: A comprehensive literature search was conducted on the PubMed, Web of Science, Scopus, and Cochrane Central Register of Controlled Trials databases. The search terms used were "self-adhesive composite" or "self-adhesive flowable composite."

(iii) Search Strategy: A total of 14 complete articles were screened and evaluated.
(iv) Data extraction: Only relevant articles that met the review's objectives (clinical follow-up studies of restorations performed

with self-adhesive resins applied to enamel and/or dentin) were considered. Thus, of the 14 complete articles, 12 were selected.

3. RESULTS

A total of 14 potentially relevant records were identified in the database and examined by titles and abstracts, of which two were excluded for not meeting the eligibility criteria. A total of 12 studies met the selection criteria and were included in this review (Table 1).

4. DESCRIPTIVE ANALYSIS

This review assessed five distinct commercial brands of self-adhesive flowable composite resins (Table 2). Among the studies included, Vertise Flow resin (Kerr Corporation, Orange, CA, USA) was evaluated in six studies [1,2,15–18], while Fusio Dentin Liquid (Pentron Clinical, Orange, CA, USA) was examined in three [19–21]. Additionally, one study investigated Self-adhesive Bulk Fill Restorative (3M Oral Care, St Paul, MN, USA) [22], another focused on Filtek Supreme Ultra Flowable (3M ESPE, USA) [23], and Constic (DMG; Hamburg, Germany) was analyzed in a separate study [3].

In addition, different conventional fluid composite resins were used as a comparison parameters. Two studies evaluated Filtek™Z350-XT Flowable, 3M ESPE, USA (conventional fluid resin, total-etch) [16,18] and Tetric® N-Flow (Ivoclar Vivadent, Delhi, India) (conventional flowable resin, total-etch) [19,20]. Flowable resins, with one evaluation each were Premise Flowable, Kerr, Orange, CA, USA (conventional flowable resin, total-etch) [17], Filtek Z250 (3M ESPE, St. Paul, MN, ABD) (conventional fluid resin, total-etch) [1], Filtek One Bulk Fill (3M Oral Care, St. Paul, MN, USA) [22] (bulk fill resin), Filtek Supreme Ultra (3M ESPE, USA) (conventional resin) [23], Luxa Flow (DMG, Hamburg, Germany) (conventional resin) [15]. All conventional flowable composite resins were applied to their respective adhesive systems. The comparison also evaluated the resin-based sealant Helioseal-F (Ivoclar Vivadent, Delhi, India) [21].

Another material evaluated in the comparison was resin-based sealant Helioseal-F (Ivoclar Vivadent, Delhi, India) [21].

5. DISCUSSION

This systematic review aimed to gather information on the clinical performance of restorations made with self-adhesive composite resins.

The review showed that the main self-adhesive flowable resins evaluated were Vertise Flow (Kerr Corporation, Orange, CA, USA) [1,2,15–18], and Fusio Dentin Liquid (Pentron Clinical, Orange, CA, USA) [19–21], Self-adhesive Bulk Fill Restorative (3M Oral Care, St Paul, MN, USA) [21], Filtek Supreme Ultra Flowable (3M ESPE, USA) [22], and Constic (DMG; Hamburg, Germany) [3].

Studies have shown that conventional and self-adhesive fluid composite resins have comparable clinical performances [2,16–19,21,22]. This was evidenced both in Class I restorations [2,15,16,18,20-23], as well as Class II [17,19] and Class V [22].

Studies with follow-up between 12 and 24 months in permanent teeth showed that in Class I restorations the clinical efficacy of self-adhesive flowable composite resin exhibited characteristics similar to conventional flowable composite resin [3,16,20-23]. There was no significant difference in color matching, marginal fit [3,18,20,23], postoperative sensitivity, and marginal discoloration [2,3,15,18,20,23]. However, in restorations in areas that receive high occlusal loading, the use of flowable composite resins is recommended only as a cavity base [23]. When used as an intermediate layer between the adhesive system and the hybrid composite, the flowable composite is ideal for absorbing the stress generated by overlaying the more rigid resin [15].

The adhesion of self-adhesive fluid composite resin compared to etching and rinsing adhesive systems was positive [17,19]. The advantage in clinical procedures is that it is a simpler and less technically sensitive material, and the high wettability of these self-adhesive fluid resins allows for better penetration into uneven surfaces of cavities. In addition, due to its ability to form thin layers, it eliminates the incorporation of air bubbles [17]. However, the disadvantage is the presence of a higher percentage of the organic matrix, which contributes to increased water solubility, compromising long-term restorations [15]. The lower amount of inorganic filler impairs shear strength and is therefore generally not recommended as a restorative material in cavities with a high occlusal function [15,18,21]. And they are dimensionally unstable because they contain hydrophilic monomers [2,16].

Table 1. Data from the studies included in the review

Study	Year	Country	Number of teeth (per group)	Type of tooth	Material	Type of material
AlHumaid [19]	2018	Saudi Arabia	20	Permanent anterior tooth	● Fusio Liquid Dentin (Pentron Clinical Technologies) ● Tetric N-Flow (Ivoclar Vivadent, Delhi, India)	Self-adhevise flowable resin ● Conventional flowable resin
Cieplik [22]	2021	Germany	30	Premolar and permanent molar	● Self-adhesive bulk-fill restorative (3M Oral Care, St Paul, MN, USA) ● Filtek™ One Bulk Fill (3M Oral Care, St Paul, MN, USA)	● Self-adhevise flowable resin ● Conventional flowable resin
Gayatri [20]	2018	India	22	Premolar permanent	● Dyad Flow (Kerr Products, Delhi, India) ● Tetric N-Flow (Ivoclar Vivadent, Delhi, India)	● Self-adhevise flowable resin ● Conventional flowable resin
Lawson [23]	2015	United Stataes	60	Premolar and permanent molar	● Filtek Supreme Ultra Flowable (3M ESPE, USA) Filtek Supreme Ultra (3M ESPE, USA)	● Self-adhevise flowable resin ● Conventional flowable resin
Liu [3]	2023	China		Occlusal cavities in permanent teeth.	● Fusio Liquid Dentin (Pentron Clinical Technologies) ● Vertise Flow (Kerr Corporation, Orange, CA) ● Constic (DMG; Hamburg, Germany)	● Self-adhevise flowable resin ● Self-adhevise flowable resin ● Self-adhevise flowable resin
Oz (Oz *et al.*, 2016)	2020	Turkey	32	Permanent molar	● Vertise Flow (Kerr Corporation, Orange, CA) Luxa Flow (DMG, Hamburg, Germany)	● Self-adhevise flowable resin ● Conventional flowable resin
Sabbagh [17]	2017	Lebanon	34	Permanent molar	● Vertise Flow (Kerr Corporation, Orange, CA) ● Premise flowable (Kerr Corporation)	● Self-adhevise flowable resin ● Conventional flowable resin
Serin [1]	2019	Turkey	31	Deciduous molar	● Vertise Flow (Kerr Corporation, Orange, CA) ● Filtek Z250 (3M ESPE, St Paul, MN, ABD)	● Self-adhevise flowable resin ● Conventional flowable resin
Shaalan [16]	2018	Egypt	18	Premolar and permanent molar	● Vertise Flow (Kerr Corporation, Orange, CA) ● Filtek™Z350-XT (3M ESPE, USA)	● Self-adhevise flowable resin ● Conventional flowable resin
Shaalan [18]	2021	Egypt	18	Premolar and	● Vertise Flow (Kerr Corporation, Orange,	● Self-adhevise flowable resin

Study	Year	Country	Number of teeth (per group)	Type of tooth	Material	Type of material
				permanent molar	CA) ● Filtek™Z350-XT (3MESPE, USA)	● Conventional flowable resin
Vichi [2]	2013	Italy	40	Pré-molar e molar permanente	● Vertise Flow (Kerr Corporation, Orange, CA)	● Self-adhevise flowable resin
Wadhwa [21]	2018	India	80	Molar permanente	● Dyad Flow (Kerr Products, Delhi, India) ● Helioseal-F (Ivoclar Vivadent, Delhi, India)	● Self-adhevise flowable resin ● Conventional flowable resin

Table 2. Self-adhesive flowable composite resins evaluated

Materials/ Manufacturers	Description	General composition	Instructions for use
Vertise Flow, (Kerr Corporation, Orange, CA)	Self-adhesive flowable composite resin	GPDM and methacrylate monomers, pre-polymerized fillers, barium glass, nanometer colloidal silica, and nanometer ytterbium fluoride.	Dispense Vertise Flow into the cavity with the dispenser tip provided. Use the supplied brush to apply Vertise Flow to the cavity wall with moderate pressure for 15–20 s to obtain a thin layer (<0.5 mm). Light cure for 20 s. After lining the cavity wall, build the restoration with more Vertise Flow in 2mm increments or less. Light cure each increment for 20 s.
Fusio Liquid Dentin (Pentron Clinical, Orange, USA)	Self-adhesive flowable composite resin	4-MET and fillers (65% by weight).	Dispense an initial coat onto a dry surface; Brush the surface for 15-20 s with moderate pressure and light cure for 20 s; Apply additional material from the syringe in less than 2 mm increments and light cure each increment for 20 s.
Self-adhesive Bulk Fill Restorative (3M Oral Care, St Paul, MN, USA)	Self-adhesive flowable composite resin	Cross-linking dimethacrylate and TEGDMA, strontium-fluoro-alumino-silicate, and zirconia-silica.	Mix in a capsule mixing device for 15 s and deposit in the unconditioned well. Light cure for 20 s.
Filtek Supreme Ultra Flowable (3M ESPE, USA)	Self-adhesive flowable composite resin	Treated silanized ceramic, substituted dimethacrylate, bisGMA, silane-treated silica, TEGDMA, ytterbium fluoride, reacted polycaprolactone polymer and diphenyl iodonium hexafluorophosphate and fillers (65% by weight).	Dispense Filtek Supreme Ultra Flowable into the cavity with the applicator tip. Insert and cure restorative in less than 2 mm increments and light cure each increment for 20 s.
Constic (DMG; Hamburg, Germany)	Self-adhesive flowable composite resin	MDP, bisphenol A-glycidyl methacrylate, EBADMA, urethane dimethacrylate, HEMA, TEGDMA, and HDMA.	Clean the tooth by rinsing the prepared cavity with water spray and thoroughly drying it with air. Apply a 0.5 mm thick layer of Constic using the Luer-Lock-Tip and brush for 25 seconds. Remove any excess material. Light-cure for 20 seconds.

- GPDM: glycerol phosphate dimethacrylate; 4-MET: 4-methacryloxyethyl trimethyl acid; TEGDMA: triethylene glycol dimethacrylate; MDP: Methacrloxydecyl dihydrogen phosphate; EBADMA: ethoxylated bisphenol A dimethacrylate; urethane dimethacrylate; HEMA: 2-hydroxy ethyl methacrylate; HDMA: 1,6-hexanediol dimethacrylate

In Class II cavities, self-adhesive flowable composite exhibited mechanical and biological properties similar to conventional flowable composite, without the occurrence of exacerbated fractures and acceptable postoperative sensitivity [17,19]. However, restorations with self-adhesive flowable composite resin showed deviations in terms of translucency and surface gloss, which were significantly lower than restorations with conventional flowable composite resin. This can be attributed to the composition of the material itself, as it has small porosities and voids, which increases the marginal discoloration of the restorations over time [19]. In addition, another negative aspect of Class II self-adhesive fluid resin restorations is microleakage [17], which decreases the marginal adaptation [19] of the proximal boxes [17]. Over time, restorations with this material showed steps and minor irregularities, which were not observed in flowable composite [19].

In Class V cavities, the adhesion efficiency is better evaluated because these cervical lesions do not have any macro mechanical retention. An 18-month study showed that self-adhesive flowable composite restorations demonstrated good color stability with superior performance concerning marginal discoloration and integrity when compared to conventional flowable resin. The self-adhesive flowable composite provided a better finish after polishing than the conventional flowable composite [22].

According to the literature review of in vivo studies, self-adhesive flowable resin exhibited comparable outcomes to conventional flowable resin [2,16–19,22]. However, studies have shown that for restorations in Class I and V cavities, self-adhesive flowable composite resin performed better than restorations in Class II cavities. Despite these findings, the study on self-adhesive composite resins encountered several notable limitations. Primarily, the scarcity of clinical data available for analysis may have hindered a comprehensive assessment. Additionally, the search strategy might have overlooked relevant literature, thus constraining the breadth of the review. Furthermore, the narrow selection criteria for clinical follow-up studies could have excluded valuable insights from other sources. Lastly, the potential for publication bias introduces a caveat to the interpretation of the findings. It is imperative to acknowledge these limitations when evaluating the implications drawn from the study.

6. CONCLUSION

According to the review carried out, it can be concluded that:

- The self-adhesive flowable resin showed comparable results with the conventional flowable resin.
- The self-adhesive flowable resin obtained better results in class I and V cavity restorations than in class II cavities.

CONCENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Serin BA, Yazicioglu I, Deveci C, Dogan MC. Clinical evaluation of a self-adhering flowable composite as occlusal restorative material in primary molars: One-year result., Eur. Oral Res. 2019;53:119–124. Available:https://doi.org/10.26650/eor.20190025 PM - 31579892.
2. Vichi A, Margvelashvili M, Goracci C, Papacchini F, Ferrari M. Bonding and sealing ability of a new self-adhering flowable composite resin in class I restorations. Clin. Oral Investig. 2013;17:1497–1506. Available: https://doi.org/10.1007/s00784-012-0846-6 PM - 23086332.
3. Liu RX. Zhang XY, Hua FL, Zhang ZC. Self-adhesive flowable composite resins and flowable composite resins in permanent teeth with occlusal cavities: A systematic review and meta-analysis. J. Dent. 2023;138:104691. Available:https://doi.org/10.1016/j.jdent.2023.104691 PM - 37683798.
4. Garcia RN, Silva CS, Silva GG, Mocellin G, Ozelame J, Fracasso L, Ozelame MB, do Nascimento RF, Gomes ACR. Bonding performance of a self-adhering flowable composite to indirect restorative materials. Rev. Sul-Brasileira Odontol. 2014;11:6–12. Available:file:///D:/JULIO/Citavi_Projetos/Pibic_Cassia_2021_Resina_Autoadesiva/Citavi Attachments/153029831002.pdf.
5. Poss SD. Utilization of a new self-adhering flowable composite resin. Dent. Today. 2010;29:104–105.

6. Jordehi AY, Shahabi MS, Akbari A. Comparison of self-adhering flowable composite microleakage with several types of bonding agent in class V cavity restoration. Dent. Res. J. (Isfahan). 2019;16: 257–263.
Available:file:///D:/JULIO/Citavi_Projetos/Pibic_Cassia_2021_Resina_Autoadesiva/Citavi Attachments/Jordehi, Shahabi et al. 2019 - Comparison of self-adhering flowable composite.pdf.
7. Yuan H, Li M, Guo B, Gao Y, Liu H, Li J, Evaluation of Microtensile Bond Strength and Microleakage of a Self-adhering Flowable Composite. J. Adhes. Dent. 2015;17: 535–543.
Available:https://doi.org/10.3290/j.jad.a35253 PM - 26734678 M4 - Citavi.
8. Yoshida Y, Nagakane K, Fukuda R, Nakayama Y, Okazaki M, Shintani H, Inoue S, Tagawa Y, Suzuki K, Munck J, van Meerbeek B. Comparative study on adhesive performance of functional monomers. J. Dent. Res. 2004;83:454–458.
Available:https://doi.org/10.1177/154405910408300604 PM - 15153451.
9. Salerno M, Derchi G, Thorat S, Ceseracciu L, Ruffilli R, Barone AC. Surface morphology and mechanical properties of new-generation flowable resin composites for dental restoration. Dent. Mater. 2011;27:1221–1228.
Available:https://doi.org/10.1016/j.dental.2011.08.596 PM - 22000067.
10. Czasch P, Ilie N. *In vitro* comparison of mechanical properties and degree of cure of a self-adhesive and four novel flowable composites. J. Adhes. Dent. 2013;15:229–236.
Available:https://doi.org/10.3290/j.jad.a29530 PM - 23560255.
11. Wei Y, Silikas N, Zhang Z, Watts DC. Hygroscopic dimensional changes of self-adhering and new resin-matrix composites during water sorption/desorption cycles. Dent. Mater. 2011;27:259–266.
Available:https://doi.org/10.1016/j.dental.2010.10.015 PM - 21111476.
12. Wei Y, Silikas N, Zhang Z, Watts DC. Diffusion and concurrent solubility of self-adhering and new resin-matrix composites during water sorption/desorption cycles. Dent. Mater. 2011;27:197–205.
Available:https://doi.org/10.1016/j.dental.2010.10.014 PM - 21084109.
13. Peterson J, Rizk M, Hoch M, Wiegand A. Bonding performance of self-adhesive flowable composites to enamel, dentin and a nano-hybrid composite. Odontology. 2018;106:171–180.
Available: https://doi.org/10.1007/s10266-017-0324-3 PM - 29243187.
14. Baroudi K, Rodrigues JC. Flowable Resin Composites: A Systematic Review and Clinical Considerations. J. Clin. Diagn. Res. 2015;9:ZE18-24.
Available:https://doi.org/10.7860/JCDR/2015/12294.6129 PM - 26266238.
15. Oz FD, Ergin E, Cakir FY, Gurgan S. Clinical Evaluation of a Self-Adhering Flowable Resin Composite in Minimally Invasive Class I Cavities: 5-year Results of a Double Blind Randomized, Controlled Clinical Trial. Acta Stomatol. Croat. 2020;54:10–21.
Available:https://doi.org/10.15644/asc54/1/2 PM - 32523153.
16. Shaalan OO, Abou-Auf E, El Zoghby AF. Clinical evaluation of self-adhering flowable composite versus conventional flowable composite in conservative Class I cavities: Randomized controlled trial. J. Conserv. Dent. 2018;21:485–490.
Available:https://doi.org/10.4103/JCD.JCD_210_18 PM - 30294107.
17. Sabbagh J, Dagher S, El Osta N, Souhaid P. Randomized Clinical Trial of a Self-Adhering Flowable Composite for Class I Restorations: 2-Year Results. Int. J. Dent. 2017:5041529.
Available:https://doi.org/10.1155/2017/5041529 PM - 28348594.
18. Shaalan OO, Abou-Auf E. A 24-Month Evaluation of Self-Adhering Flowable Composite Compared to Conventional Flowable Composite in Conservative Simple Occlusal Restorations: A Randomized Clinical Trial. Contemp. Clin. Dent. 2021;12:368–375.
Available:https://doi.org/10.4103/ccd.ccd_600_20 PM - 35068835.
19. AlHumaid J, Al Harbi FA, ElEmbaby AE. Performance of Self-adhering Flowable Composite in Class V Restorations: 18 Months Clinical Study. J. Contemp. Dent. Pract. 2018;19:785–791.
20. Gayatri C, Rambabu T, Sajjan G, Battina P, Priyadarshini MS, Sowjanya BL. Evaluation of Marginal Adaptation of a Self-Adhering Flowable Composite Resin Liner: A Scanning Electron Microscopic

Study. Contemp. Clin. Dent. 2018;9:S240–S245.
Available:https://doi.org/10.4103/ccd.ccd_156_18 PM - 30294151.

21. Wadhwa S, Nayak UA, Kappadi D, Prajapati D, Sharma R, Pawar A. Comparative Clinical Evaluation of Resin-based Pit and Fissure Sealant and Self-adhering Flowable Composite: An In Vivo Study. Int. J. Clin. Pediatr. Dent. 2018;11:430–434.
Available: https://doi.org/10.5005/jp-journals-10005-1552 PM - 30787558.
22. Cieplik F, Scholz KJ, Anthony JC, Tabenski I, Ettenberger S, Hiller KA, Buchalla W, Federlin M. One-year results of a novel self-adhesive bulk-fill restorative and a conventional bulk-fill composite in class II cavities-a randomized clinical split-mouth study. Clin. Oral Investig. 2022;26:449–461.
Available: https://doi.org/10.1007/s00784-021-04019-y PM - 34129074.
23. Lawson NC, Radhakrishnan R, Givan DA, Ramp LC, Burgess JO. Two-year Randomized, Controlled Clinical Trial of a Flowable and Conventional Composite in Class I Restorations. Oper. Dent. 2015;40:594–602.
Available: https://doi.org/10.2341/15-038-C PM - 26237643 M4 - Citavi.
24. Miletic V. Dental Composite Materials for Direct Restorations. Springer International Publishing, Switzerland; 2018.
Available: https://doi.org/10.1007/978-3-319-60961-4 M4 - Citavi.

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