



An In Vitro Comparison of Work of Fracture Load in One-Piece Milled, Two-Piece Milled, and Conventionally Processed Complete Dentures

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Introduction

Over 36 million Americans are completely edentulous.¹ Even with implant technology, complete dentures remain the most common prosthesis offered to patients in the world.^{2,3} Despite material improvements, denture base fractures still occur.^{3,4,5,6} CAD/CAM makes denture fabrication more efficient.^{7,8} While additive technology appears promising, improvements are needed before use as definitive prostheses and limitations include esthetics, retention, occlusion, and printer resolution.² Studies show 3D printed CDs are weaker compared with milled or conventionally processed CDs.⁹ Subtractive manufacturing studies show that milled CDs have superior flexural strength and offer other improved mechanical properties compared to conventionally processed CDs.^{10,11,12,13} Recently, Ivoclar® (Schann, Liechtenstein) released a one-piece millable disc, which includes the base and the denture teeth. There are claims that one-piece products are stronger compared to two-piece systems. But due to the recent release, independent comparative studies are lacking.

Objectives

Prior research studies investigated the flexural strength of milled complete dentures (CDs), revealing superior results to conventional and 3-D printed CDs. However, studies comparing two-piece milled and bonded CDs with one-piece milled CDs remain sparse. This study aims to evaluate fracture load of different denture materials and compare *the work of fracture load* of Ivobase® High Impact (conventionally processed), Ivobase® CAD (two-piece milled), and Ivotion® (one-piece milled) CDs.

Methods

A laboratory desktop scanner was used to scan a mandibular edentulous cast. Subsequently, a complete denture was designed and fabricated using varying materials, with twelve samples per group. Group 1 utilized an Ivobase® High Impact (injection molding) with Ivoclar Blue Line® denture teeth. Group 2 used an Ivobase® CAD disc and denture teeth bonded with Ivoclar bonding agent. Group 3 Ivotion® disc (Fig. 1). The dentures were artificially aged, mounted, and loaded at a rate of 1 mm per minute on a universal testing machine (Fig. 2). The maximum fracture load (N) was recorded, and *the work of fracture load* (kJ) was then calculated.



Fig 1. Ivotion® (Left, one-piece), Ivobase® High Impact (Middle, conventional), Ivobase® CAD (Right, two-piece).

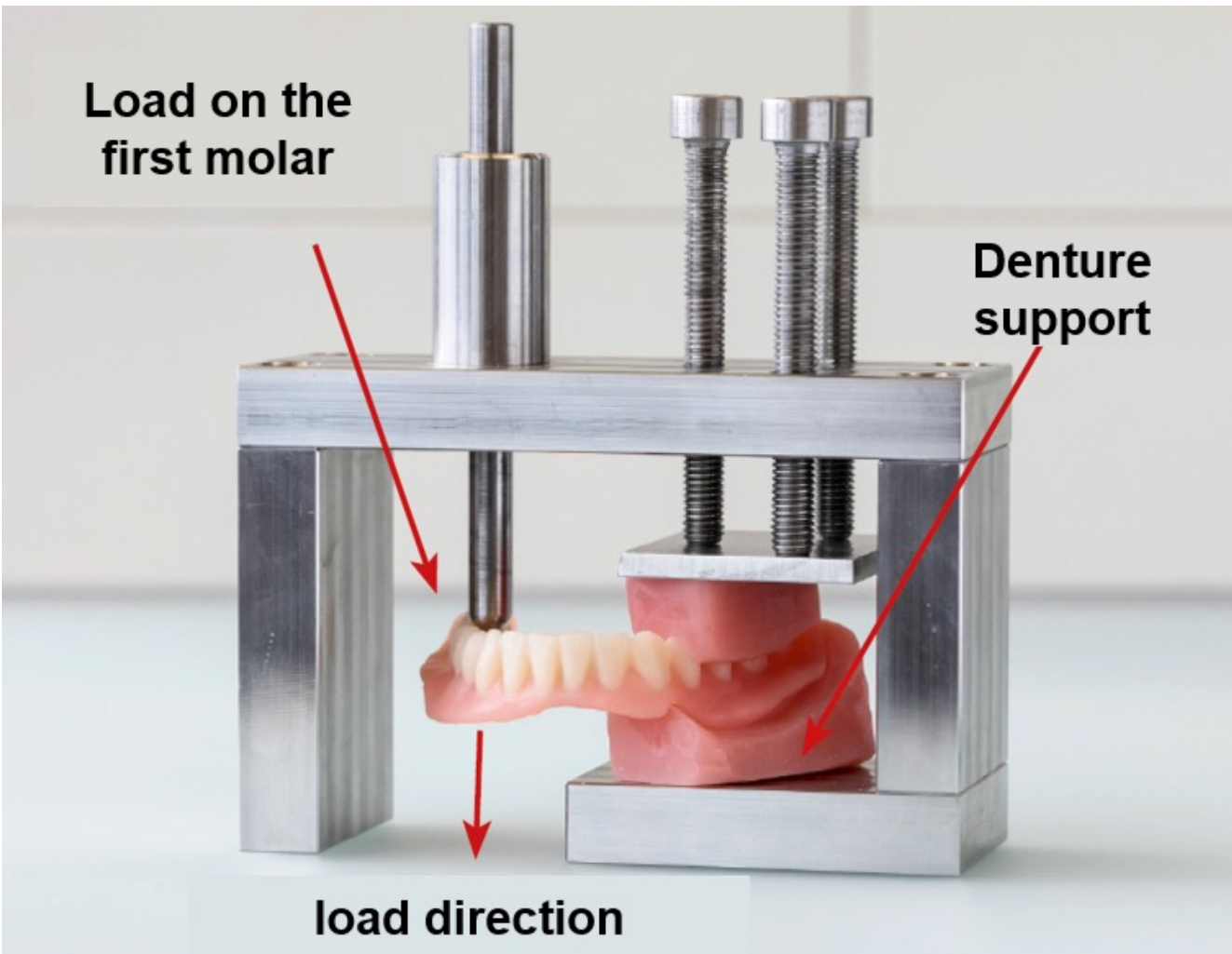


Fig 2. Display of the specimen under load using a universal testing machine.

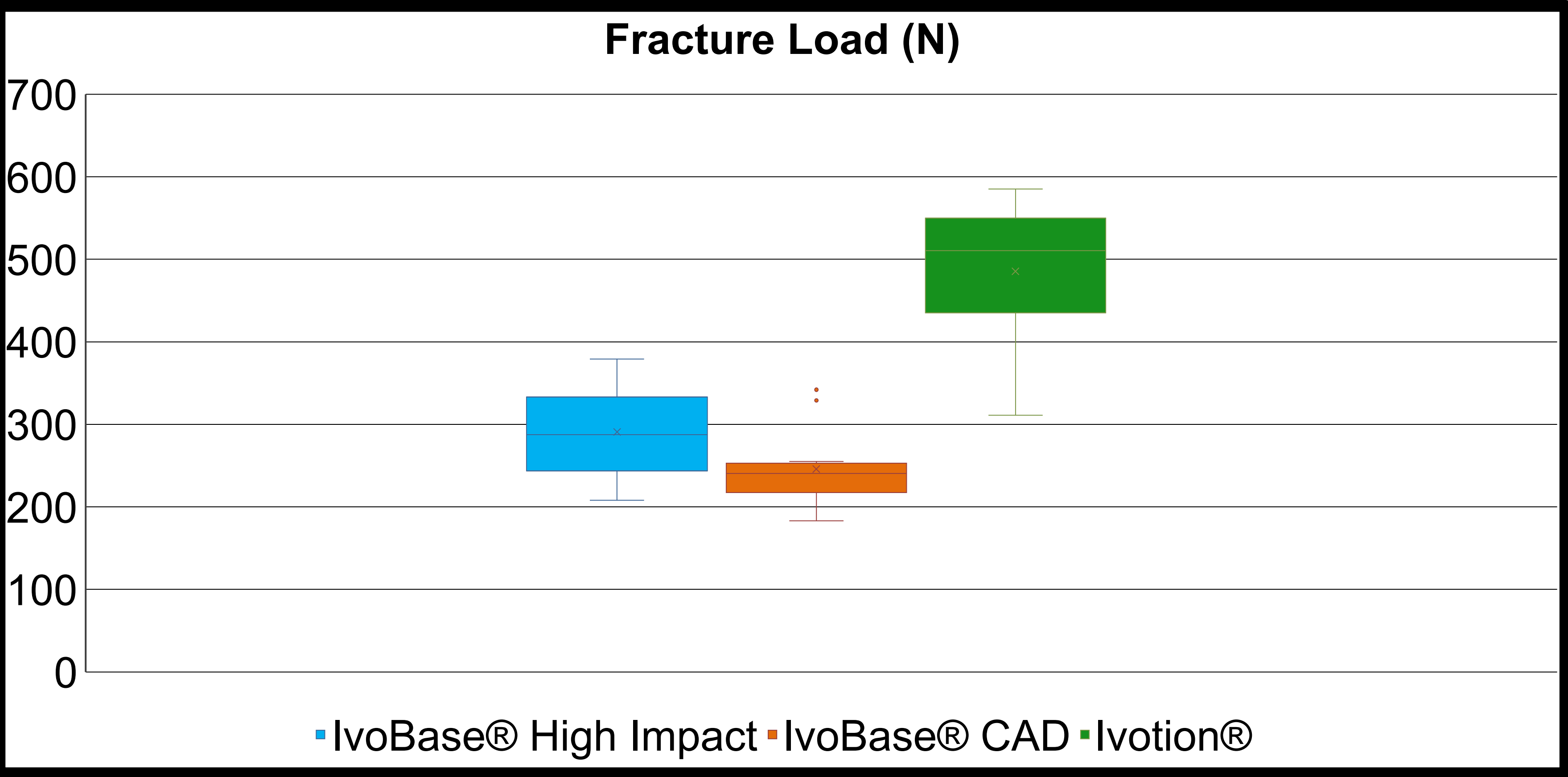


Fig 3. Box and whisker plot for the two experimental groups and control group.

	Mean Work of Fracture Load (kJ)	Standard Deviation
Ivobase® High Impact	1.82	0.61
Ivobase® CAD	1.58	0.28
Ivotion®	3.22	0.87

Table 1. Mean work of fracture and standard deviation values for the two experimental groups and one control group.

Results

The mean fracture loads recorded for the Ivobase® High Impact, Ivobase® CAD, and Ivotion® groups were 290.83 N, 246 N, 485.42 N respectively. The mean work of fracture loads for the Ivobase® High Impact, Ivobase® CAD, and Ivotion® groups were 1.82 kJ, 1.58 kJ, 3.22 kJ respectively (Table 1, Fig 3). A One-way ANOVA and Tukey test revealed a statistically significant difference between the Ivotion® group and the other two groups ($P<0.05$). There was no significant differences found between the Ivobase® CAD and the Ivobase® High Impact groups.

Conclusion

Within limitations of this study, it can be concluded that the Ivotion® CD group had the highest fracture load and *work of fracture load*, which was statistically significant compared to the Ivobase® High Impact and Ivobase® CAD groups.

References

- Centers for Disease Control and Prevention. (2021, December 9). Edentulism and tooth retention. Centers for Disease. Control and Prevention.
- Anadioti, E, et al. 3D Printed Complete Removable Dental Prostheses: A Narrative Review. BMC Oral Health 2020;20.
- Srinivasan, M et al. CAD/CAM milled removable complete dentures: time and cost estimation study. J Dent 2019;80:75-9.
- Ettinger RL, Qian F. Longitudinal assessment of denture maintenance needs in an overdenture population. J Prosthodont 2019;28:22-9.
- Darbar UR, Huggett R, Harrison A. Denture fracture--a survey. Br Dent J 1994;176:342-55.
- Hargreaves AS. The prevalence of fractured dentures. A survey. Br Dent J 1969;126:451–55.
- Choudhary, S. Complete denture fracture - A proposed classification system and its incidence in National Capital Region population: A survey. J Indian Prosthodont Soc 2019;19:307-12.
- Kalberer, N, et al. CAD-Cam Milled versus Rapidly Prototyped (3D-Printed) Complete Dentures: An in Vitro Evaluation of Trueness. J Prosthet Dent 2019;121:637-43.
- Ulmer, M. Biocompatibility and mechanical/physical properties of 3D printed, milled, and conventionally processed denture base materials. Diss. Augusta University, 2019.
- Arslan M, Murat S, Alp G, et al. Evaluation of flexural strength and surface properties of prepolymerized CAD/CAM PMMA-based polymers used for digital 3D complete dentures. Int J Comput Dent 2018;21:31-40.
- Al-Dwairi ZN, Tahboub KY, Baba NZ, et al. A comparison of the flexural and impact strengths and flexural modulus of CAD/CAM and conventional heat-cured polymathy methacrylate (PMMA). J Prosthodont 2018;29:341-49.
- Prpic, V, et al. Comparison of Mechanical Properties of 3d-Printed, CAD/CAM, and Conventional Denture Base Materials. J Prosthodont 2020;29:524-28.
- Srinivasan, M, et al. CAD-Cam Removable Complete Dentures: A Systematic Review and Meta-Analysis of Trueness of Fit, Biocompatibility, Mechanical Properties, Surface Characteristics, Color Stability, Time-Cost Analysis, Clinical and Patient-Reported Outcomes. J Dent 2021;113:103.

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