



A COMPARATIVE ANALYSIS OF INSTRUMENT SEPARATION USING PROTAPER GOLD AND GENENDO SYSTEM:AN IN VITRO STUDY

Dr. S. Anitha Rao	Professor & HOD, Department of Conservative Dentistry and Endodontics, Mamata Dental College, Khammam-507002.
Dr. V. Chandrasekhar	Professor, Department of Conservative Dentistry and Endodontics, Mamata Dental College, Khammam-507002
Dr. Srirangam Sai Sri	Postgraduate Student, Department of Conservative Dentistry and Endodontics, Mamata Dental College, Khammam-507002.

ABSTRACT **Background And Objective:** Instrument separation (IS) remains a highly concerning dental event even with advancements in endodontic file designs and stronger metal alloy file structures. The aim of this study is to assess the longevity of an instrument in how many canals or teeth can be used before separation. **Materials And Methods:** Forty extracted molars were chosen for this study and randomly divided into two groups. The Teeth in group 1 were instrumented with the Protaper gold system. Teeth in group 2 were instrumented with the Gen Endo system. The instrumentation of teeth was done as per the manufacturer's instructions. Instruments were used until they were separated and were replaced with new instruments. Mann-Whitney U test was used to compare file separation occurrence. **Results:** Overall comparison of median canal count in which file got distorted among two groups showed a significant difference among two groups with Protaper Gold file system showing higher mean rank (greater canal count at which instrument got distorted or separated) as compared to the GenEndo group. **Conclusion:** Based on the results of this study, the incidence of endodontic instrument separation when using the Protaper gold was considerably low compared to the Gen Endo system.

KEYWORDS : Protaper gold, Gen Endo, Instrument separation, Rotary nickel–titanium

INTRODUCTION:

The fundamental goal of endodontic therapy is the thorough cleaning and shaping of the root canal system by removing infected pulp tissue, bacteria, and their byproducts. In today's competitive field of endodontics, practitioners must have a strong understanding of both the biological and mechanical properties of their instruments.

Instrument separation is one of the most common procedural complications encountered during root canal therapy.¹ This frustrating mishap prevent access to the apex by impeding full length instrumentation and obturation of the root canal further raising the case difficulty index and challenging healing. Despite taking extensive preventive measures, this issue remains prevalent not only among students and general dentists but also among experienced specialists.² The frequency of file separation four-folds with manufacturing flaws, imperfections in its physical properties, aberrant anatomy of the root canal, insufficient access, incorrect use and technical errors.³

Over the past two decades, nickel-titanium (NiTi) instruments have become indispensable in root canal treatment.³ Ongoing advancements in endodontic instrument design and NiTi alloy technology aim to reduce the risk of rotary instrument separation and deformation during chemo-mechanical preparation. The likelihood of instrument separation impacting treatment outcomes depends on the condition of the pulp and the complexity of the root canal anatomy. Severely curved canals present a greater risk of instrument separation or deformation, making effective cleaning and shaping more challenging. In such cases, retrieving a broken instrument without compromising the tooth structure can be extremely difficult, if not impossible.⁴

The ProTaper Gold (Dentsply Sirona, Ballaigues, Switzerland) is an enhanced version of the ProTaper Universal, featuring an improved NiTi alloy. According to the manufacturer, a patented heat treatment process creates a gold-colored titanium oxide layer on the instrument's surface, enhancing its mechanical properties. This modification improves flexibility, fatigue resistance, cutting efficiency, and canal centering ability.^{5,6}

The GenEndo system is designed for efficiency and ease of use, incorporating specialized instruments for coronal flaring, glide path preparation, canal shaping, and final cleaning and finishing. Each tool is engineered with advanced technology to optimize flexibility and resistance to fracture, making them highly reliable in clinical practice.⁷ This study aims to evaluate the longevity of these instruments by determining the number of canals or teeth they can be used on before separation occurs.

MATERIALS AND METHODS:

This study was approved by the Institutional Ethics Committee (approval number: MDC-R-088486). Forty Extracted maxillary and mandibular molars for various reasons were collected from the tooth bank. To interpret the normal clinical situation no standardization of root curvature was considered. Sample were randomly divided into two groups according to different systems used.

Teeth with roots had mature apices and minimal caries (Score 3 according to ICDAS) were included in the study. Calcified teeth were excluded from the study, which were confirmed using radiographs before instrumentation. The teeth were decontaminated by immersion in 5.25% Sodium hypochlorite for 30 min. Teeth were then stored in saline at room temperature until use.

After access cavity preparation, 10k file was inserted into the Mesio buccal canals to reach apical foramen. Root canals working length was calculated by taking 1mm away from apical foramen. Later 15k file was used to create a glide path. All instruments were used with the Endo motor handpiece (Endogold woodpecker). One operator performed all instrumentation. Each instrument was evaluated through naked eye before use for any manufacturing defects.

Teeth were then employed to prepare canals utilizing Protaper gold and Gen Endo file system. Torque and rotational speed were used as recommended by manufacture instructions. Instruments were used sequentially i.e SX, S1, S2, F1 for Protaper gold (Dentsply Sirona, Ballaigues, Switzerland) only in mesiobuccal canal. Coronal Flare (CF), Glide Path Flare (GPF), Preparation File (PF), Universal Finishing File (UF) For Genendo System (By Micro Mega, Manufactured Specially for Coltene India) only in mesio buccal canal. Separated instruments were replaced with new ones of the same size to continue the sequential instrumentation. Following use of each Instrument 1ml of 5.25% NaOCl irrigation was done, and RC Help (17% EDTA with carbamide peroxide) was used as lubricant. Normal saline is used as last rinse to remove any remaining chemical irrigant. Between uses they were sterilized, cleaned with a wet gauze, inspected and replaced if any deformation was visible through stereomicroscope.

Statistical Analysis:

The data were statistically evaluated with Mann-whitney U test (significance level was set at $p < 0.05$). Data were performed using SPSS 21 software.

RESULTS:

On Intragroup comparison of Protaper Gold system, Median canal count of instrument separation for Sx was seven; S1 was seven, and

similar data (eight) were found with S2 & F1 instruments which was statistically insignificant, where as in case of GenEndo system, Median canal count of instrument separation for CF and GPF file was five; for PF file was six, and for UF1 instrument was eight (Figure 1).

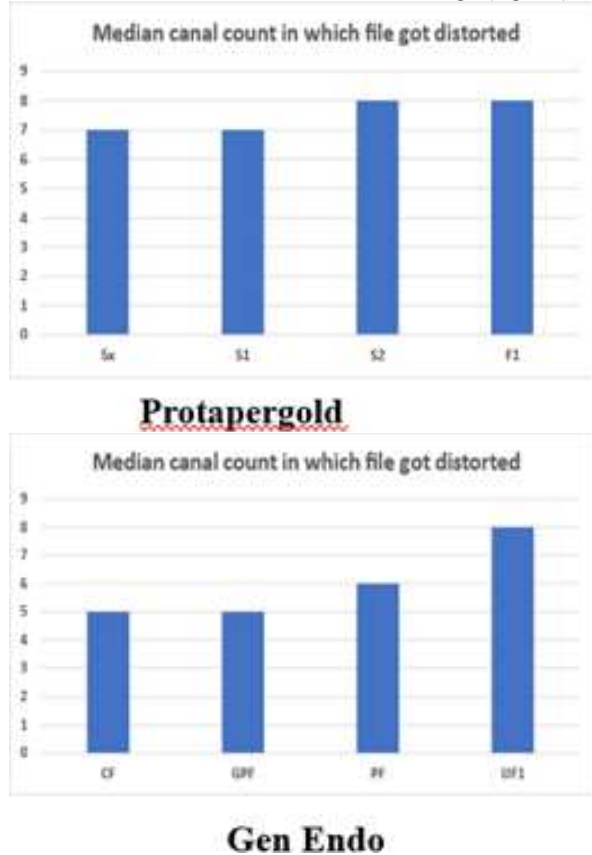


Figure 1: Comparison Of Mean Canal Separation In Protaper Gold And Genendo Systems Respectively

Overall comparison of median canal count in which instrument got distorted among two groups showed a significant difference among two groups with Protaper Gold instrument system showing higher mean rank (greater canal count at which instrument got distorted) as compared to the GenEndo group (Table 1).

Table 1: Comparison Of Mean Canal Separation In Both Protaper Gold And GenEndo systems

Protaper Gold	GenEndo	P-value
S _x : 7	CF: 5	0.031*
S ₁ : 7	GPF: 5	
S ₂ : 8	PF: 6	
F ₁ : 8	UF ₁ : 8	
Mean rank: 15.54	Mean rank: 9.46	

DISCUSSION:

Despite significant advancements in alloy composition and instrument design, instrument separation during root canal shaping remains a concern. This complication can occur unexpectedly, even in the absence of visible signs of instrument fatigue or deformation.⁸ Posterior teeth are the ideal candidates for this study due to their complex anatomy and the increased likelihood of instrument failure.^{9,10}

Thorough cleaning and shaping of the root canal system is a vital step in endodontic treatment. Nickel-Titanium (NiTi) rotary instruments have transformed this process by significantly reducing procedural errors such as canal transportation, zipping, ledging, and perforations, which were more common with traditional stainless-steel instruments. However, one inherent drawback of NiTi rotary instruments is their susceptibility to intracanal separation.¹¹

In the present study, Protaper Gold instrument system has less mean instrument distortion with increasing order of Sx; S1, S2 & F1 instruments when compared to the GenEndo group with increasing order of CF, GPF, PF UF1. The probable reason for less instrument separation in Protaper gold is due to progressive taper gold heat-treated

files with a convex triangular cross-section, non-cutting tip, and enhanced flexibility and cyclic fatigue resistance which was in accordance to Vashist et al, Oztan et al, Usta et al, Marya et al, Tyagi et al and Martins et al which stated that Protaper gold owes high lifespan and durability of under controlled conditions.^{12,13,14,15,16,17}

According to Sattapan et al., NiTi instrument separation typically occurs via two mechanisms: torsional fracture and flexural fatigue.¹⁸ Studies indicate that 55.7% of instrument failures result from torsional stress, while 44.3% are due to flexural fatigue.⁹ Continuous cycles of compression and tension within a curved canal can lead to flexural fractures, whereas torsional fracture occurs when the instrument binds at a point other than its tip. Clinically, endodontic files inside the root canal are subjected to both torsional stress and cyclic fatigue, and these forces influence each other.¹⁸ Swiss researchers have identified excessive force as a primary cause of instrument separation.⁹

CONCLUSION:

In conclusion it is important that a clinician be very familiar with the manufacturer's directions for any Ni-Ti rotary file system. Applying too much force apically, skipping file sizes, a lack of effective irrigation between instrument use, or neglecting to evaluate instrument for any form of distortion or uneven wear before use can all lead to eventual distortion or separation. Within the limitation of this study, the incidence of endodontic instrument separation when using the Protaper gold was considerably low compared to Gen Endo system.

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