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Assessing the Influence of Type of Base Materials on Choosing Permanent Restoration in Pulp Capping - A Retrospective Analysis

KEERTHIKA. R[1], SUBASH SHARMA[2*], SURENDAR SUGUMARAN[3]

[1]Saveetha Dental College and Hospitals, Saveetha Institute of Medical And Technical Sciences, Saveetha University, Chennai, India.
[2]Reader, Department of Conservative dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical And Technical Sciences, Saveetha University, Chennai, India.
[3]Senior lecturer, Department of Conservative dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical And Technical Sciences, Saveetha University, Chennai, India.
*Corresponding Author
Email ID: keerthikar91@gmail.com[1], subash@saveetha.com[2], surendars.sdc@saveetha.com[3]

Abstract: The success of vital pulp therapy techniques is considerably dependent on the technique employed,the inflammatory status of the pulp tissue,the type of pulp therapy agent used and period of observation. The commonly used agents are calcium hydroxide ,Resin modified glass ionomer cement and mineral trioxide aggregate. The permanent restoration following the pulp capping plays a very crucial role in the success of the treatment. The commonly used restorations are composites,amalgam and bilayered restoration.The aim of this study was to assess the type of base materials in pulp capping and its influence on permanent restoration.A cross sectional study done at Saveetha Dental College with the sample size of 69 was analysed. The factors like age ,gender,base material ,type of teeth and permanent restoration were assessed. The P value of less than 0.05 was considered to be significant.Result of type of base material showed,Calcium hydroxide >Calcium hydroxide +Resin modified glass ionomer cement >Bio aggregate material and the permanent restoration showed Composite >Bilayered restoration > Amalgam.The statistical analysis showed the p value =0.338(>0.05) ,which implies that there is no significant association between the type of base material with the type of permanent restoration.The current study showed that calcium hydroxide and composite restoration were the preferred options of base material and permanent restoration respectively.But with recent advances it has been proved that Bioaggregate material has better properties than calcium hydroxide ,which is no longer a gold standard material.

Keywords: Bioaggregate ;Calcium hydroxide;Composite;Pulp capping ;Resin modified glass ionomer cement, innovative

INTRODUCTION

Vital pulp therapy is designed to preserve and maintain pulpal health in the teeth that have been exposed to trauma ,caries ,restorative procedures and anatomic anomalies (Hargreaves, Cohen and Berman, 2011). The aim of the vital pulp therapy is to preserve the vitality and function of the coronal or remaining radicular pulp tissue(Ward, 2002).Vital pulp therapy is recommended for all teeth diagnosed with reversible pulpitis or partially inflamed pulp in which the remaining healthy tissue can be conserved to generate a hard tissue barrier that seals and protects the pulp from future microbial insult(Hargreaves, Cohen and Berman, 2011) .

Vital pulp therapy techniques that are used for treatment of cariously exposed permanent teeth include(Calişkan, 1995)

- Indirect pulp capping
- Direct pulp capping
- Partial pulpotomy
- Full coronal pulpotomy

Direct pulp capping is defined as placing a dental material directly on a mechanical or traumatic vital pulp exposure and sealing the pulpal wound to facilitate the formation of reparative dentin and maintenance of the vital pulp.The procedure is indicated for pulp exposure incurred as a result of caries removal ,trauma or tooth preparation (American Association of Endodontists, 2003).Indirect pulp capping is defined as a procedure performed in a tooth with a deep carious lesion approximating the pulp but without signs or symptoms of pulp degeneration.

It is indicated in a permanent tooth diagnosed with a normal pulp with no signs or symptoms of pulpitis or with a diagnosis of reversible pulpitis(Soleiman *et al.*, 2015). The foremost objective in vital pulp is to encourage protective hard tissue barrier formation after injury(Hargreaves, Cohen and Berman, 2011).

The repair process after pulp capping is characterised by four steps(Goldberg, Lasfargues and Legrand, 1994)

- Moderate inflammation
- Recruitment and advance of dedicated adult reserve stem cells
- Proliferation of the progenitor cells
- Terminal differentiation.

The success of vital pulp therapy technique in cariously exposed permanent teeth is dependent upon the technique employed ,the inflammatory status of the pulp tissue ,the type of pulp therapy agent used and the period of observation(Waterhouse *et al.*, 2008).A variety of pulp dressing materials have been investigated and used over the past century to encourage bridge formation and pulp preservation.

Calcium hydroxide,zinc oxide ,Calcium phosphate,zinc oxide ,calcium tetracycline chelate ,zinc phosphate and poly carboxylate cement,Bioglass ,Emdogain,antibiotic and growth factor combinations,Ledermix ,calcium phosphate ceramics,cyanoacrylate ,hydrophilic resins ,Resin modified glass ionomer cement,hydroxyapatite compounds and recently Mineral Trioxide Aggregate(Li *et al.*, 2015; Katge and Patil, 2017; Torabinejad, Parirokh and Dummer, 2018) .Other strategies designed to arrest invasive caries and promote repair of underlying tissue include the use of lasers ,ozone technology ,silver diamond fluoride and Bioactive glasses that stimulate the pulpal defence mechanisms(Burke, 2012).

Among all the available pulp capping materials,Calcium hydroxide is considered as "gold standard "for several decades.Calcium hydroxide has outstanding antimicrobial properties. The most desirable properties of calcium hydroxide are initial high alkaline pH,which stimulates fibroblasts and enzyme systems.It neutralises the low pH of acids,shows antibacterial properties and promotes pulp tissue defence mechanism and repair . The drawbacks of calcium hydroxide include weak marginal adaptation to dentin ,degradation and dissolution overtime and primary tooth resorption(Hargreaves, Cohen and Berman, 2011).

Resin modified glass ionomer cement has also been used for pulp capping in combination with Calcium hydroxide.TEGDMA ,a common dentin bonding compound ,differently increase the levels of apoptosis and necrotic cell populations after direct exposure.They provide excellent seals when combined with light cured composite in permanent restorations(do Nascimento *et al.*, 2000; Chen and Suh, 2017).

Bioaggregate material has also been used as pulp capping material . The cement consists of hydraulic calcium silicate powder containing various oxide compounds,including calcium oxide ,ferric oxide ,silicon oxide ,sodium and potassium oxide ,magnesium oxide and aluminium oxide.Mineral trioxide aggregate promotes a biocompatible ,non cytotoxic ,antibacterial environment and surface morphology that are favourable for reparative calcification bridge formation.(Camilleri and Pitt Ford, 2006)

The placement and quality of the permanent restoration plays a crucial role in long term maintenance of pulp vitality. The aim of the final restoration is to complement the sealing ability of the pulp capping material and effectively defend the pulp from further microbial challenges(Hargreaves, Cohen and Berman, 2011).

Amalgam remains the most widely used restorative material because of its ease of use,durability and low cost.However due to drawbacks like esthetic limitations and high modulus of elasticity it is not used widely nowadays. The technology driven adhesive dentistry has improvised the use of new composites and bonding resins.Thus it has been proved that modern adhesives are proved to be a predictable partner that complements vital pulp therapy.Several research (Li *et al.*, 2015; Torabinejad, Parirokh and Dummer, 2018)has been done on the various pulp capping agents and their potentials has been delineated.Since the pulp therapy is influenced by multiple factors,all those factors couldn't be assessed in a single study.

This study tried to correlate the type of the base material used during pulp capping with the permanent restoration used ,which could be helpful in implementing it in the hospital setup.Previously our team has done numerous clinical studies (Ramamoorthi, Nivedhitha and Divyanand, 2015; Nasim *et al.*, 2018; Janani, Palanivelu and Sandhya, 2020)and questionnaire surveys (Manohar and Sharma, 2018; Jose, P. and Subbaiyan, 2020)and in vitro studies(Ramanathan and Solete, 2015; Nasim and Nandakumar, 2018; Ramesh, Teja and Priya, 2018; Rajendran *et al.*, 2019; Siddique and Jayalakshmi, 2019) and literature reviews(Noor, S Syed Shihaab and Pradeep, 2016; Kumar and Delphine Priscilla Antony, 2018; Ravinthar and Jayalakshmi, 2018; R, Rajakeerthi and Ms, 2019) in the past decade,now we are focussing on the epidemiological surveys. Our department is passionate about research we have published numerous high quality articles in this domain over the past years ((Kavitha *et al.*, 2014) , (Praveen *et al.*, 2001),(Devi and Gnanavel, 2014), (Putchala *et al.*, 2013), (Vijayakumar *et al.*, 2010), (Lekha *et al.*, 2014a, 2014b) (Danda, 2010) (Danda, 2010) (Parthasarathy *et al.*, 2016) (Gopalakannan, Senthilvelan and Ranganathan, 2012), (Rajendran *et al.*, 2019), (Govindaraju, Neelakantan and Gutmann, 2017), (P. Neelakantan *et al.*, 2015), (PradeepKumar *et al.*, 2016), (Sajan *et al.*, 2011), (Lekha *et al.*, 2014a), (Neelakantan, Grotra and Sharma, 2013), (Patil *et al.*, 2017), (Jeevanandan and Govindaraju, 2018), (Abdul Wahab *et al.*, 2017), (Eapen, Baig and Avinash, 2017), (Menon *et al.*, 2018), (Wahab *et al.*, 2018), (Vishnu Prasad *et al.*, 2018), (Uthrakumar *et al.*, 2010), (Ashok, Ajith and Sivanesan,

2017), (Prasanna Neelakantan *et al.*, 2015). The idea for this survey stemmed from current interest in our community.The aim of this study was to assess the influence of various types of base materials on choosing the permanent restoration.

MATERIALS AND METHOD

Study design and setting

This study was done in Saveetha dental college ,Chennai .This study was approved by SRB committee of the Saveetha Dental College the ethical number SDC/SIHEC/2020/DIASDATA/0619-0320. Inorder to avoid bias ,two reviewers were included.It was done from one particular university setting hence it should be improved to include a wider population for better results.

Data collection

The data was obtained from electronic database of Saveetha Dental College from the period of July 2019 to April 2020.All cases which underwent pulp capping were assessed .Inclusion criteria: Both males and females of age group 18-60 years were included ,all teeth which underwent permanent restoration after pulp capping were included.Exclusion criteria :Age group below 18 years and above 60 years were excluded,primary teeth were excluded ,pulp capping with intermediate restoration not included.Data without incomplete details were excluded.Sampling bias excluded by having two reviewers and the samples were cross verified by photographic evaluation.Thus finally the sample examined were 69 in number.

Statistical analysis

The acquired data were recorded in Microsoft excel and later exported to IBM SPSS software (version20.0 Chicago,USA) for statistical analysis.Chi square test was then employed with the level of significance set at $P<0.05$.The statistical analysis between age,gender,teeth number,reason for retreatment were analysed using IBM SPSS software (version20.0 Chicago,USA) .The outcome was represented in a form of tables and bar charts.

RESULTS AND DISCUSSION

Among the age groups studied ,age group of 18-30 years showed predominance with n=34 ,followed by 31-40 years (n=21)and 41-50 years (n=8)and 51-60 years (n=6)(Fig I).Similar result was found in the study by Yeon cho et al 2013(Cho *et al.*, 2013),Dammaschke et al 2010 (Dammaschke, Leidinger and Schäfer, 2010)and Wildeshausen et al 2011(Willershausen *et al.*, 2011).It can be justified by the fact that the prognosis of the vital pulp therapy also depends on the age ,which highly influence the regeneration and repairing capacity of the tissues.

Among the gender predilection,Male (n=43)underwent more pulp capping procedure than female (n=26). But there has been no literature supporting the gender predilection for pulp capping procedure.(Fig II)

The type of teeth showed predominance of mandibular posteriors (n=42) than maxillary posteriors (n=22)and maxillary anteriors.A similar study was observed by Barthe et al 2000,Percisa et al 1981 with the mandibular posterior being the most common teeth undergoing treatment.But Yeon cho et al 2013(Cho *et al.*, 2013) and Maroli 1992 (Büyükgüral and Cehreli, 2008)does not find any significant difference among the distribution of teeth (Fig III).It can be justified by the fact that the caries predominance was seen more in Mandibular posteriors than maxillary posteriors thus supporting the current study.

Among the base materials studied,calcium hydroxide(n=42) showed predominance followed by Calcium hydroxide and Resin modified glass ionomer cement (n=17) and Bioaggregate (n=10)(Fig IV).Calcium hydroxide was considered as gold standard material for pulp capping.But due to the advancement in adhesive dentistry nowadays the biomimetic materials are used in large number of cases . The studies done before a decade like wellington et al (Rosa *et al.*, 2018)and Schwendicke et al(Schwendicke, Brouwer and Stolpe, 2015) supported the use of Calcium hydroxide as base materials.But currently many invitro and clinical trials has proved Mineral trioxide aggregate as better option.Contraindicating the current study ,the better material of choice for pulp capping recommended by the evidence based literature being Mineral trioxide aggregate.

The permanent restoration plays a very crucial role in the success of the vitality treatment .Among the various permanent restoration evaluated in this study composite (n=39) showed predominance followed by bilayered restoration (n=28)and amalgam (n=2)(Fig V) .The current study was supported by Kocvoral et al 2017(Koc-Vural *et al.*, 2017),orphan 2010(Erdemli *et al.*, 2010)which composite is better option and Rosenberg 2013 showed RMGIC could also be a material of choice. There is no available literature to contradict the importance of permanent restoration over the success of the treatment.

The meta analysis by Li z et al(Li *et al.*, 2015) showed MTA as a better option in composition to calcium hydroxide.a study by Katie et al also showed better clinician hydroxide.

The limitations of this study is that it is done in small certain groups,which can't be applied over a larger population and the multiple interrelated factors are not considered. The studies in future should focus on the

recent advanced materials by including multiple factors and the sample size has to be larger. The follow up period and the outcome measures were not well defined which has to be considered in the future studies.
The statistical analysis showed the p value >0.05(0.338) (Table I),which implies that there is no significant association between the type of base material with the type of permanent restoration.It has also been inferred that calcium hydroxide was the most preferred base material over the calcium hydroxide and resin modified glass ionomer cement combination and mineral trioxide aggregate and composite were the most preferred permanent restoration over the bilayered restoration and amalgam restoration (Fig VI).

CONCLUSION

Within the limitations of this study,it can be concluded that calcium hydroxide and composite restoration are the preferred choice of the base material and permanent restoration for pulp capping procedures.With the advancement in materials science and evidence based research Calcium hydroxide is no longer considered as the gold standard material for pulp capping. Hence the recent advanced material like Mineral trioxide aggregate has to be considered a better option than Calcium hydroxide.

Author Contribution

First author in this study has contributed to data collection ,data analysis and in the preparation of manuscript .The second author has contributed to data analysis and preparation of the manuscript and editing.The third author has contributed to the supervision and preparation of the manuscript.

Conflict of Interest

None

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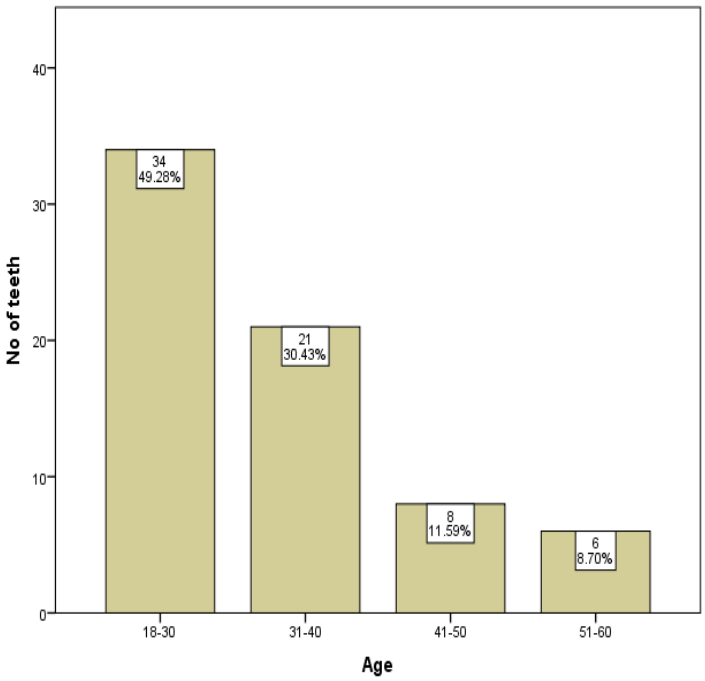

Fig.1: Bar chart showing the distribution of age group and number of teeth in the study population from 18-30 yrs,31-40 yrs,41-50 yrs and 51-60 yrs with x axis denoting age groups and y axis denoting the number of teeth involved. This Graph infers that age between 18-30 yrs showed more case distribution followed by 31-40 yrs, 41-50 yrs, 51-60 yrs.

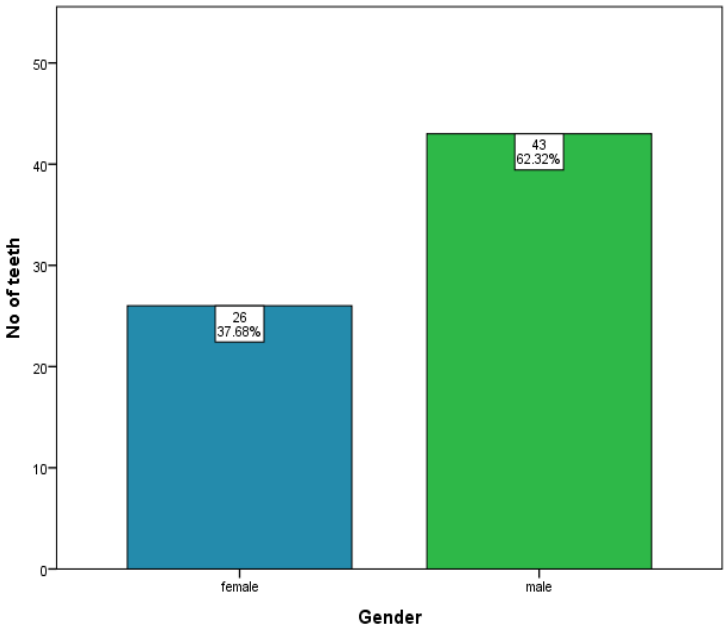

Fig.2:Bar chart showing the distribution of gender of the study population and the number of teeth with X axis showing distribution of gender and Y axis shows the number of teeth involved, where blue denotes female and green denotes male. From this graph we infer that male patients showed the maximum number of pulp capping cases than the female patients.

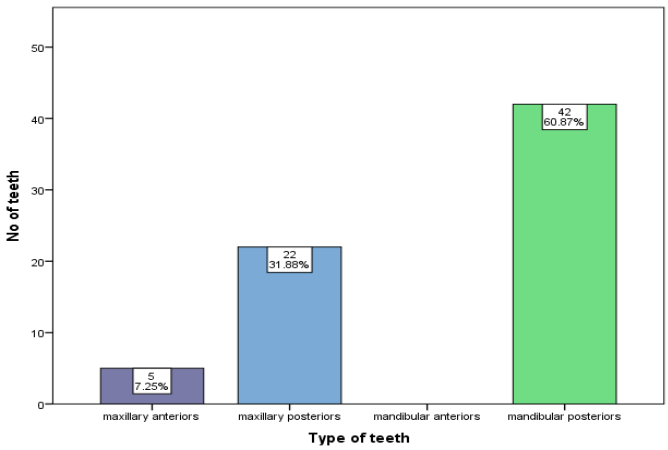

Fig.3:Bar chart showing the distribution of teeth among the study population and the number of teeth with X axis denotes the type of teeth and Y axis denotes the number of teeth where purple denotes the maxillary anteriors ,blue denotes maxillary posteriors and green denotes mandibular posteriors.from this graph we infer that mandibular posteriors showed maximum number of pulp capping cases followed by maxillary posteriors and maxillary anteriors.

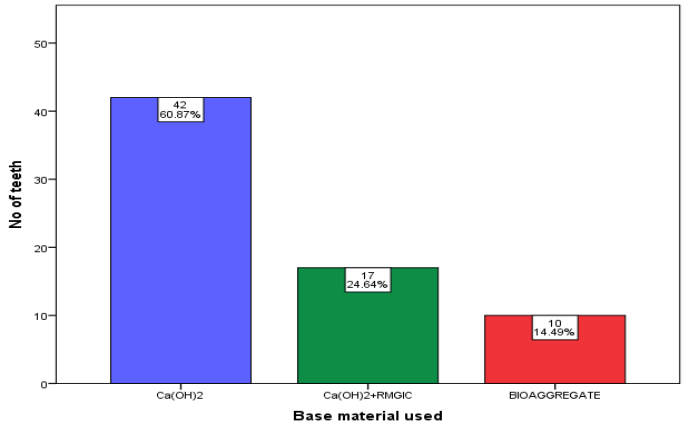

Fig.4: Bar chart showing the distribution of type of base material used and the number of teeth with X axis denoting the base material used and Y axis denoting the number of teeth where blue denotes Ca(OH)2,green denotes Ca(OH)2 + RMGIC and red denotes Bio aggregate materials . Graph shows that the most preferred base material is Ca(OH)2 followed by Ca(OH)2 + RMGIC and Bio aggregate materials respectively.

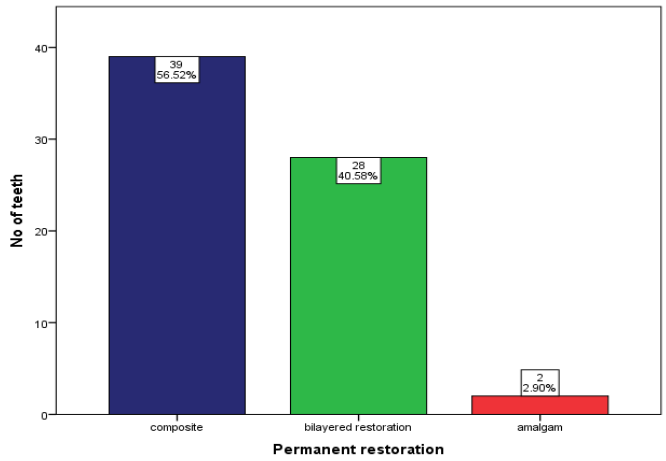

Fig.5: Bar chart showing the distribution of type of permanent restoration(X axis) and the number of teeth (Y axis) were blue denotes composites,(56.5%),green denotes bilayered restoration(40.6%),red denotes amalgam(2.9%).From this graph we infer that the composites were the most preferred permanent restorative material followed by bilayered restoration (GIC as base and composite) and amalgam.

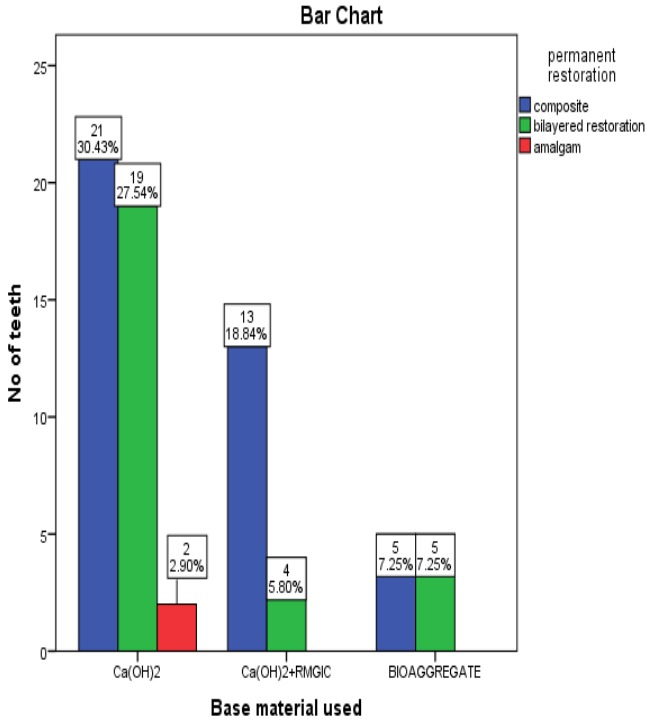

Fig.6: Bar chart showing the association of permanent restorative materials among the different type of base materials(X axis) and the number of teeth (Y axis).Graph shows that calcium hydroxide and composites(Blue) are the preferred choice of the base material and permanent restoration for pulp capping procedures. Pearson's chi square p value :0.338(>0.05)hence statistically not significant,proving no significant association between the type of base material and the permanent restoration.

Table 1: Shows the chi square test for association of the type of base material with the type of permanent restoration.The p value >0.05(0.338) ,which implies that there is no significant association between the type of base material with the type of permanent restoration.

	Value	df	Asymptotic significance (2sided)
Pearson Chi square	4.535	4	.338
Likelihood ratio	5.327	4	.255
Linear- by -Linear association	.863	1	.353
N of valid cases	69		