Statement of problem: Different Pontic design and materials have been advocated for fixed partial dentures. However, scientific evidence is lacking to help clinicians to make a proper selection.

Purpose: The purpose of this systematic review was to evaluate the effects of different pontic designs and materials on the residual ridge mucosa.

Materials & methods: The literature search was conducted in PubMed, EBS CO, Google Scholar and manual search with no publication year limits. The primary clinical question was framed according to the Problem/Patient/Population, Intervention/Indicator, Comparison, Outcome (PICO) approach. In vivo, English language studies evaluating the effect of Pontic designs and materials on the residual ridge mucosa were included in this systematic review.

Results: The search identified 301 references. After analysis, Ten clinical studies met the eligibility criteria and were included for qualitative analysis. Included studies had 400 cases who received different pontics in respect to design and materials. Six evaluation methods were used to investigate the relationship between pontics and residual ridge mucosa.

Conclusion: Based on the available evidence and within the limitations of this systematic review, this study demonstrated that patients maintaining the high standard of oral hygiene are able to prevent the development of inflammatory changes in the alveolar mucosa in contact with pontics. Regarding the choice of pontic materials, literature shows that there is no statistically significant difference between various materials but the glazed porcelain was the most hygienic material. Regarding the choice of pontic design, though all included studies used different pontic design but ridge lap pontics have been shown to produce mucosal inflammation and modified ridge lap and sanitary pontics should be more preferable compared to other pontic design.
INTRODUCTION:
The pontic is the unit of a fixed partial denture that replace missing natural teeth and must satisfy several needs. They must restore function, be hygienically maintainable, be biologically and esthetically acceptable and be comfortable to the patient. The rehabilitation of a patient prosthodontically not only involves the rehabilitation of lost teeth but to restore the lost functionality and appearance too.2 The role of mechanical irritants in periodontal disease has been discussed in many reports that primarily involve the teeth and their supporting tissues. References to fixed prostheses direct attention to the irritating effects of improperly constructed pontics.3 Many types of pontics are available for the situations that arise in fixed partial prosthodontics. But the controversy is centered on whether or not a pontic should contact the ridge tissue, and if so, whether or not it should exert pressure on that tissue.4

A number of opinions have been expressed regarding the cause of unfavourable tissue response to fixed partial denture pontics.5 Pronounced inflammatory changes and even ulceration of the alveolar mucosa beneath bridge pontics are rather common findings after removal of fixed bridges.6

Regarding the pontic materials, there is disagreement as to which is the best material. Despite an abundance of clinical observation of inflammatory changes in tissues contacted by pontics, little scientific evidence supports a preference for one specific design and material.7 In the course of time, many studies concerning the etiology of pathologic tissue reactions in the alveolar ridge mucosa beneath bridge pontics have been carried out. Most attention has been paid to the influence of pontic material properties. Other studies have paid attention to the design of the pontic and the degree of contact between the pontic and the oral mucosa.8

Hence, the present systematic review was conducted to evaluate which pontic materials and designs are more favourable than others to the underlying mucosa. Hence, the present systematic review was conducted to evaluate the relationship of pontic design and materials with residual ridge mucosa.

MATERIAL AND METHODS
pontic design or type of pontic materials, Pilot studies, Vitro studies. Any decision about the inclusion/exclusion in the review was made by consensus.
RESULTS

The initial electronic search yielded 301 titles. After removing duplicates, 244 remained. Of these, 177 Records were excluded because they are Irrelevant to search objectives. Among which 46 records were excluded during abstract reading. 21 were selected for full-text analysis and 11 were excluded because they did not meet the inclusion/exclusion criteria. 10 studies were included in the systematic review (Fig. 1).

The included articles were published between 1966 and 2017. All of the articles were in English, and all the 10 eligible studies were in vivo studies investigating Pontic - Mucosa Relation.

The minimum number of specimens per group was 5,6 while the maximum number of specimen per group was 500.3 Six evaluation methods were used to investigate the Relationship between Pontics and Residual Ridge Mucosa, among which Clinical evaluation and histological evaluation by biopsy method were most commonly used, followed by Microbiological evaluation using culture media, morphometric evaluation with 400 magnification, evaluation by using indices, and a questionnaire based study.

Histological evaluation of mucosa by biopsy in four studies revealed that inflammatory reactions of the underlying mucosa were found upon removal of pontic. Whereas 2 studies proved that there were no differences between pontic sites and control sites with regard to histologic findings.

In clinical examination one study revealed some clinical evidence of inflammation in Over 33 per cent of all Pontics areas. In another study evaluation of soft tissue was made and there was an unfavorable tissue change present (around 28%) under the porcelain interchangeable flatback facings and 43% for polished acrylic resin in maxillary pontics, and Unfavorable tissue change around 33% for long pin, 20% for gold with ovoid and 66% for acrylic in mandibular pontics. Clinical evaluation of mucosa regarding color, contour, and texture of the tissue contacting the pontic revealed that Clinically, there was no evidence that the oral
mucosa responded more favorably to any one of the pontic materials.\textsuperscript{4} Where as Arlon G evaluated that there are less clinical findings in glazed porcelain compared to other pontic materials.\textsuperscript{7} Saul M. Hirshberg evaluated mucosal response using three different types of pontic design. The ridgelap pontics were found to be less desirable than spheroid or modified spheroid pontics in maintaining mucosal health since inflammation developed beneath them. Changing the ridgelap pontic to the modified spheroid type alleviated inflammation.\textsuperscript{10}

Regarding the microbiological evaluation using culture media, a study revealed that the microflora consisted mainly of Gram-positive cocci and rods and to a lesser extent of Gram-negative cocci and rods.\textsuperscript{8} In contrast to this study, no bacterial deposits were detected at the surfaces of pontics.\textsuperscript{6} Another study evaluated the difference between sanitary and ridge lap pontics using questionnaire and they found that 85\% had no complaint with concern to prosthesis.\textsuperscript{2}

The characteristics of the included studies are presented in Table 1 (Master table).

<table>
<thead>
<tr>
<th>Author / Year</th>
<th>Sample Size</th>
<th>Time of evaluation</th>
<th>Pontic Region</th>
<th>Pontic Design/Materials</th>
<th>Evaluation Methods</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajat R. 2017\textsuperscript{2}</td>
<td>40 cases</td>
<td>1 month</td>
<td>-</td>
<td>1. sanitary 2. Ridge lap</td>
<td>Questionnaire based</td>
<td>Sanitary pontic gives good results when cleansing is the main concern and where aesthetics is to be considered ridge lap is the choice of pontic.</td>
</tr>
<tr>
<td>Ali Afzal et al 2015\textsuperscript{1}</td>
<td>40 cases</td>
<td>6 week 12 week 6 month</td>
<td>Mandibular first molar region</td>
<td>1. Modified ridge lap 2. Ridge lap</td>
<td>Condition of Mucous membrane &amp; Abutment teeth using indices by Carrenza 1996</td>
<td>Regarding tissue response, condition of interdental papillae and condition of abutment teeth modified ridge lap Pontic has better result compare to ridge lap pontic.</td>
</tr>
<tr>
<td>Authors</td>
<td>Cases</td>
<td>Study Duration</td>
<td>Region</td>
<td>Pontic Material</td>
<td>Clinical Assessments</td>
<td>Histologic Assessments</td>
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<tr>
<td>Nicola et al 2002</td>
<td>12</td>
<td>12 months</td>
<td>Maxilla</td>
<td>Ovate Pontic</td>
<td>1. Clinical evaluation: Gingiva Index 2. Histologic assessments: Soft Tissue Biopsy (Leitz DM-RBE microscope) 3. The morphometric measurements were determined by a point-counting procedure (original magnification □400).</td>
<td>With good oral hygiene, restoring an edentulous space with an ovate pontic was not associated with overt clinical signs of inflammation. Histologically, this pontic design was associated with a thinner keratin layer. No differences were observed between pontic sites restored with porcelain or resin veneering.</td>
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<tr>
<td>Helle et al 1988</td>
<td>5</td>
<td>4 weeks</td>
<td>Maxilla</td>
<td>Sanitary Pontic</td>
<td>1. Clinical evaluation: Gingival &amp; Plaque index, Gingival exudation by periotron 2. Microbiologic evaluation: Culture media</td>
<td>Patients who maintain a good oral hygiene are able to prevent the development of inflammatory changes in the alveolar mucosa in contact with pontics irrespective of the choice of pontic material.</td>
</tr>
<tr>
<td>Author</td>
<td>Cases</td>
<td>Type</td>
<td>Duration</td>
<td>Materials</td>
<td>Evaluation</td>
<td>Assessment</td>
</tr>
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<tr>
<td>Saul M. 1972</td>
<td>42</td>
<td>Mandibular and Maxillary ridge</td>
<td>Over a 3 year</td>
<td>Type I, Spheroid, Type II, Modified spheroid, Type III, Ridge lap</td>
<td>1. Mucosal evaluation: colour, size, shape, consistency and the presence or absence of ulceration. 2. Plaque study using a metered aerosol spray of Discloset Erythrsine B water soluble dye.</td>
<td>1. The good oral hygiene is a dominant factor in gingival health. 2. Poor oral hygiene causes inflammation of the interdental gingiva and mucosa. Even with ideal oral hygiene, there is a slight increase in the size of the interdental gingiva and mucosa. 3. There is less mucosal inflammation under spheroid or modified spheroid pontics than under ridge lap pontics.</td>
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<tr>
<td>Edmund Cavazos 1968</td>
<td>67 cases, 279 Pontics</td>
<td>Anterior Maxilla, Posterior Mandible</td>
<td>4 month</td>
<td>Maxillary pontics: 1. Long-pin facing, 2. Porcelain interchangeable fallback facings, 3. Acrylic resin, 4. Combination of 1 &amp; 2 Mandibular Pontics: 1. Long-pin, 2. Gold with ovoid or saddle pontics, 3. Acrylic with ovoid or saddle pontics</td>
<td>1. Clinical evaluation: discoloration, inflammation, proliferation or ulceration of Soft tissue. 2. Histologic assessments: Biopsy</td>
<td>Minimal contact of pontic to the tissue produced no mucosal change. The pontics must be constructed of highly glazed, high-fusing porcelain of an ovoid design with minimal adaptation to the tissue and properly reinforced with a gold alloy casting.</td>
</tr>
<tr>
<td>Arlon G. 1968</td>
<td>18</td>
<td>Mandibular and Maxillary ridge</td>
<td>6 month</td>
<td>1. Glazed porcelain, 2. Polished porcelain, 3. Polished gold Polished acrylic</td>
<td>1. Histologic assessments: Biopsy</td>
<td>There were some change of gingival tissue when all pontic materials tested for six month and after six month interval all materials tested equally well tolerated by the tissue.</td>
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</table>
## DISCUSSION

Pontic design and construction is a controversial subject complicated by an array of confusing terms, an abundance of empirical opinion, and a lack of extensive research. The importance of the pontic to the fixed prosthesis has been well stated. There is agreement that restorations and environmental demands directed on the teeth and the ridge. Any factor acting on any part of the fixed restoration affects the entire prosthesis. The pontic then, as it mechanically unifies the abutment teeth and covers a portion of the residual ridge, assumes a dynamic role as a component of the prosthesis and cannot be considered as a lifeless insert of gold, porcelain, or acrylic. In this role the pontic should restore the function of the tooth it replaces, ensure adequate sanitation, be esthetic and comfortable, and be biologically acceptable to the oral tissues.

Questions relating to pontics concern two areas: materials and design. Indeed these areas give rise to existing pontic classification and description. From the materials standpoint there are the Gold, Glazed and unglazed porcelain, Polished acrylic, silver palladium, Cobalt chromium, Nickel-chromium, Composite restorative, and combination pontics which includes gold acrylic, porcelain-fused-to-gold, and prefabricated porcelain-faced pontics. These prefabricated pontics include such types as the flat back, long pin, reverse pin, Trupontic, and Harmony pontics. On the basis of design, pontics are variously described as saddle, modified saddle, ridge lap, modified ridge lap, sanitary contoured, bullet, spheroid, modified spheroid and Unconventional pontics. Disagreement arises as to the selection and success of these various pontic materials and designs. A correctly designed posterior pontic should have the following characteristics: (1) All surfaces should be convex, smooth, and properly finished. (2) Contact with the buccal contiguous slope should be minimal (pinpoint) and pressure-free (modified ridge lap). (3) The occlusal table must be in functional harmony with the occlusion of all of the teeth. (4) The buccal and lingual shunting mechanisms should conform to those of the adjacent teeth. (5) The over-all length buccal surface should be equal to that of the

<table>
<thead>
<tr>
<th>R. Sheldonstein 1966</th>
<th>220 cases</th>
<th>6 month</th>
<th>Anterior and Posterior ridge</th>
<th>1. Snitary and Modified ridge lap 2. Gold, Porcelain and Acrylic</th>
<th>1. Visual examination: According to the extent of the irritation as severe, mild, or none. 2. Histologic assessments: Biopsy</th>
<th>The ideal design was shown to be a “modified ridge lap” in the posterior region and a “lap facing” in the anterior region. The Pontic design should include surface smoothness and a fine finish and there was no distinguishing advantage observed with porcelain, acrylic resin, or gold.</th>
</tr>
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<tbody>
<tr>
<td>Patrick J. et al 1966</td>
<td>10 cases</td>
<td>3 month 6 month</td>
<td>Mandibular ridge</td>
<td>1. Gold 2. Glazed porcelain 3. Unglazed porcelain</td>
<td>1. Clinical evaluation: color, contour, and texture of the tissue contacting the pontic. 2. Histologic assessments: Biopsy</td>
<td>As the Glazed porcelain is superior in terms of esthetics and ease of cleaning, it was the most hygienic material used. However, within six months of insertion, there was no clinical or histologic observation to suggest that glazed porcelain is superior to unglazed porcelain or polished gold, as far as tissue tolerance is concerned.</td>
</tr>
</tbody>
</table>
adjacent abutments or pontics. A correctly designed anterior pontic should have the following characteristics: (1) All surfaces should be convex, smooth, and properly finished. (2) Contact with the labial mucosa should be minimal (pinpoint) and pressure free (lap facing). Esthetics may require a long area of contact to prevent the “black space” appearance if the residual ridge is excessively resorbed. (3) The lingual contour should be in harmony with adjacent teeth or pontics.3 Patrick J. et al in 1966 did the clinical and histological evaluation of 14 pontic sites and concluded that glazed porcelain was the most hygiene material used and it is superior in terms of aesthetics and ease of cleaning.4 In converse view, Stein RS in 1966 stated that no distinguishing advantage was observed with different pontic materials.3 In another study Arlon G. Evaluated that all pontic materials tested were equally well tolerated by the tissue but there are less clinical findings with glazed porcelain as compared to gold and acrylic.7 Edmund Cavaxos in 1968 stated that the pontics must be constructed of highly glazed, high-fusing porcelain of an ovoid design with minimal adaptation to the tissue and properly reinforced with a gold alloy casting.5 Helie et al in 1988 compared the seven different pontic materials and this investigation demonstrated that patient maintaining good oral hygiene are able to prevent the development of inflammatory changes in mucosa irrespective of the pontics material used.6 Nicola Ursula Z et al (2002) used the two different pontic material with ovate pontic design and concluded that No differences were observed between pontic sites restored with porcelain or resin veneering with regard to either clinical or histologic findings.9 Choosing an appropriate pontic design in fixed prosthesis must promote health and facilitate the hygiene of the oral cavity. Pontics that stagnate the blood in the soft tissue and become foul and odoriferous are the travesty of modern dentistry.16 Stein RS in 1966 investigated tissue response with 500 pontics with two designs (sanitary and modified ridge lap) and concluded that the ideal design was shown to be “modified ridge lap” in the posterior region and “lap facing” in the anterior region.3 Khan et al in 2015 compared the tissue response between the ridgelap and modified ridgelap pontic and stated that modified ridgelap pontic had better result compared to other.1 Rajat R. (in 2017) evaluated 40 patients : out of which 20 subjects for ridgelap and 20 for Sanitary pontics were selected for questionnaire based study. The study concluded the use of sanitary pontic when cleansing is the main concern and ridgelap pontic as pontic of choice where aesthetics is to be considered.2 Hirshberg SM compared 3 types (spheroid, Modified spheroid and ridge lap) of pontic design and concluded that oral hygiene exerts more important influence on health of oral mucosa and Ridgelap pontics were less desirable than spheroid or modified spheroid pontics in maintaining mucosal health since inflammation developed beneath them. Changing the ridgelap pontic to the modified spheroid type alleviated inflammation.10 Helie et al in 1987 demonstrated that insufficient oral hygiene is an important factor in the development of inflammatory changes in the oral mucosa beneath bridge pontics.8 Therefore, the patient must develop excellent hygiene habits. Devices such as proxy brushes, pipe cleaners, Oral-B Super Floss, and dental floss with a threader are highly recommended. Gingival embrasures around the pontic should be wide enough to allow oral hygiene aids. However, to prevent food entrapment, they should not be opened excessively. To enable passage of floss over the entire tissue surface, tissue contact between the residual ridge and pontic must be passive.17 From the available studies, it seems there is a dentist cognizant of the reasons for using a particular pontic in a particular situation and a patient highly motivated and instructed as to his responsibility in caring for the component of prosthesis.14 So, as the majority of the studies show that oral hygiene is the important factor but still we can not give less preference to the selection of pontic design and its materials. High level evidence based clinical trial are required. Future studies are needed to investigate the Relationship between Pontics and Residual Ridge Mucosa.

CONCLUSION

Within the limitations of this systematic review, the following may be concluded:

1. Patients maintaining the high standard of oral hygiene are able to prevent the development of
inflammatory changes in the alveolar mucosa in contact with pontics.

2. Regarding the choice of pontic materials, there is no statistically significant difference among various materials but the glazed porcelain was the most hygienic material retaining minimal/no plaque and it is superior in terms of aesthetics and cleaning.

3. Considering the choice of pontic design, Though all included studies used different pontic design but ridge lap pontics have higher chance of mucosal inflammation due to difficulty in maintaining the hygiene and modified ridge lap and sanitary pontics are more preferable compared to others. The maintenance of utmost oral hygiene is critical to the success of all pontic designs, even those that are without any mucosal contact.

REFERENCES