

# Endoscopic Oral Splint – A Novel Design to Aid in Diagnosis and Treatment Related Clinical Procedures

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**Abstract** Endoscopy and its associated clinical procedures have relatively become a routine diagnostic procedure among various medical branches especially in gastroenterology. Having both invasive and non-invasive attributes, the procedure in its present form imparts fear and apprehension among patients, especially in patients who have a hyperactive tongue or a gag reflex. This article in the form of a clinical case report describes the fabrication of an innovative diagnostic endoscopic splint which helps both operator and patient in different ways, whereas at the same time it overcomes the problems associated with such clinical procedure.

**Keywords:** endoscopy, fiber-optic tube, gastroscopy, hyperactivity of tongue, occlusal splint

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## 1. Introduction

Investigation of the remote body recesses has always challenged the physicians, but the problems of securing a safe examination tube and proper illumination, delayed their attempts of a successful and safe examination. In 1807 Philip Bozzini was able to examine the rectum using a tin tube and candle light. Desormueux of Paris in 1865 used multiple mirrors for illumination to examine oral, anal and vaginal cavity. Basil Hirschowitz in United States devised the first totally flexible fiberoptic Endoscope in 1957. [1] Modern fiberoptic endoscope embodies the principles of optical fibers, which depend upon transmission of light waves through specially designed, highly efficient and extremely flexible glass fibers of small diameter. Glass optical fibers have more light gathering ability than plastic fibers, so they are used primarily in telecommunication. Fine plastic fibers, 2-5 nanometers diameter, are used in short distance applications like endoscopy, cystoscopy and bronchoscopy.

With the advantage of modern day video endoscope it has become possible that more than one person can watch, fourteen times magnification of body cavity which in turn have eased therapeutic and diagnostic procedures like biopsy and immersibility in cleansing solutions. [2] The basis of the present study needs an understanding of the existing problems that are encountered during the clinical procedure.

### **Existing problems encountered in clinical procedures**

During an endoscopic procedure, a patient is placed on one side (preferably left side, with head semi flexed) on

examination couch, 80 cm above the floor. As the patient is sedated, the operator is dependent on the nurse / assistant to see and hold the tube in the correct position during the entire procedure. Presently most of the diagnosticians use a mouth guard (Figure 1), which acts more of a mouth prop, only to prevent damage to the tube and prevent injury to the operator's fingers. Few endoscopic procedures like, biopsy from a fixed site, Sclerotherapy banding, etc. requires accurate fixation of the tube which is not provided by the mouth guard. Very often the mouth guard is expelled from the mouth by the struggling patient using his mobile tongue and thus increases chances of biting the delicate tube of the endoscope. Besides damaging the tube by the patients teeth, other problems include difficulty of a sedated patient to respond to commands of operator, distress produced by the endoscope in the oral cavity, gagging and struggling by the patient (even a person with high threshold to gag will continue doing so if a tube is constantly touching his oropharynx), biting of nurses/assistant's finger by sedated patient, tendency to vomit and retching. [3] Also the patient is not able to swallow when the operator needs him to swallow for pushing the tube, as he cannot move the tongue (swallowing is important as it relaxes the cricopharyngeus sphincter which in turn opens the oesophagus lumen). Forceful manipulation of the tube results in mucosal damage to the pharynx. [4,5,6] Small diameter tubes inadvertently slipping into the trachea during deliberate attempt are prone to cause tracheal stridor. There is a need to hold the insertion tube by a nurse in a suitable position so that the operator uses the thumb, index,

middle and ring finger to move the knobs for air/water channels, suction and deflection. The patient also disturbs the suitable predetermined configuration and position of the tube. Moreover the tube is not flexible in all dimensions, therefore twisting or torquing is not possible if the tube is not kept straight [7,8].



**Figure 1.** Mouth guard used for endoscopic oral procedures

## 2. Basis of Design

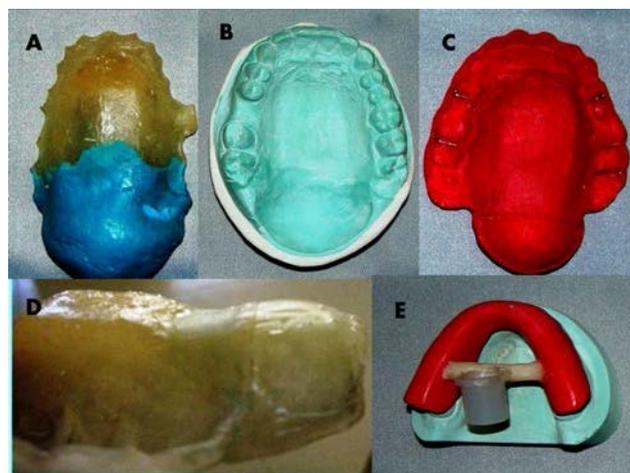
Most of the difficulties already discussed, are encountered clinically due to the movement of the fiber-optic tube by the patient's constant swallowing and retching compounded by the large size and subconscious hyperactivity of the tongue. Though one cannot demand the patient to control such intra oral hyperactivity (except under general anesthesia) which in fact is the normal protective mechanism, it is possible to splint the fiber-optic tube to the occlusal surfaces of the teeth, which when connected to the opposing teeth, would in turn not allow the endoscopic tube to move irrespective of patients extreme swallowing movements. Therefore, any endoscopic splint would have to fulfill three main objectives which are to position the tongue away from the fiber optic cord, to attach the fiber optic tube to the device and to allow the operator ease of maneuvering the cord without any resistance from oral tissues.

## 3. Clinical Report

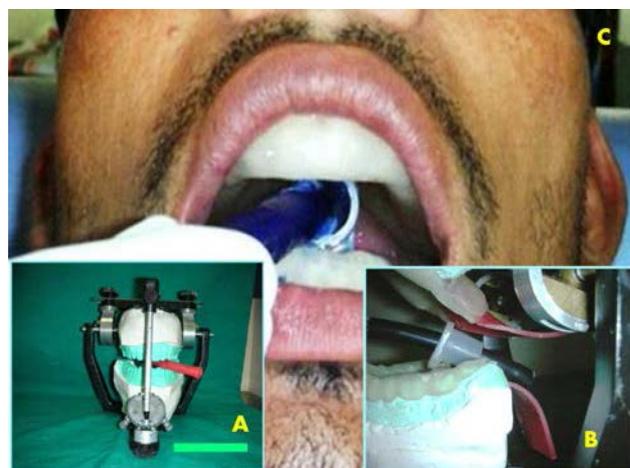
A young male patient, aged 28 years, who works in the department of Prosthodontics, had to undergo frequent endoscopy over a period of a few months in the department of radiology of Subharti University. After having encountered severe gagging problems during diagnostic endoscopy the patient approached the author whom he had observed managing patients with severe gagging while making the impressions. After consultation with the concerned department and the doctor who would perform the endoscopic procedure, a novel design for a splint was put forward. The design evolved after numerous trials and the splint discussed in this article is the final refined version of the device.

A preliminary impression of maxillary and mandibular completely dentulous arches was made using Irreversible hydrocolloid (CA 37; Cavex, Haarlem, Holland), from

which a custom tray was made using clear self-cure acrylic denture base resin (Fortex; Lucite Intl, Durham). Maxillary special tray was further modified with addition silicone polyvinyl siloxane material (Reprosil, Dentsply/Caulk; Milford, DE, USA) (Figure 2A). The modified impression was then poured with type 3 dental stone (Silky-Rock; Whip Mix Corp, Louisville) (Figure 2B). On this cast the maxillary component of the final occlusal splint was fabricated.



**Figure 2.** Components and procedures involved in fabrication of endoscopic splint (A) Putty impression material carried on special tray (B) Working cast with 2 mm scraped in the palatal region (C) Maxillary section of the splint (D) Anaesthetic reservoir in the posterior part of the maxillary section and (E) Mandibular section with tongue bar and endoscopic tubing



**Figure 3.** (A) Increased vertical dimension at which splint was fabricated (B) Lateral view of the articulator demonstrating the relation of the endoscopic tube and the splint (C) Patient wearing endoscopic splint with endoscopic tube in place

Within the posterior part of the maxillary component of the endoscopic splint, 2mm of dental stone was scraped to provide a reservoir for carrying local anesthetic gel (Figure 2D). A close adaptation of the anesthetic reservoir would keep the gel in contact with the soft palate while at the same time maintain the seal with the palatal tissues. For the mandibular section of the splint, all the natural teeth were covered with self-cure denture base acrylic resin and a bar was attached in the region of the first molar. To this bar a modified disposal syringe was attached in the middle through which the endoscopic tube would pass (Figure 2E). The thickness of the splint that would cover

the occlusal surface was determined clinically by determining the freeway space of the patient and was transferred to a semi adjustable articulator (Figure 3A). The angulation of the hollow tubing through which the endoscopic tube would pass was determined and finally attached to the maxillary component using a mechanical locking device (Figure 3B). After various trials the final version was then tried in the patient mouth who approved it for both effectiveness and comfort (Figure 3C). All the concerned doctors in the department of radiology and gastroenterology approved the design and were satisfied with the clinical result. The patient also felt more confident and less apprehensive during subsequent endoscopic procedures.

## 4. Discussion

Within the oral cavity, tongue and soft palate play significant role in swallowing and oral proprioception. [9,10,11,12] The splint was designed to counter the physiological mechanisms of both organs. With a reservoir in the maxillary section the anesthetic gel is held against the soft palate for a time long enough to induce initial anesthesia. Once the area is anesthetized it becomes easy for the patient to swallow the tube without retching. Once the tube has been placed in the stomach for some time, the problem encountered at this stage is the movement of the cord due to constant gagging and swallowing by the patient. The splint which is attached together does not allow the patient to swallow frequently. Collection of saliva at this stage was removed by a suction tip which allowed the patient to keep his mouth open for a long period of time. Because the saliva was not presented the patient was not stimulated to initiate the swallow process.

At the same time the direction of the endoscopic tube from its point of entry also changes and no longer lay in the tissues present on the lateral or pharyngeal wall. This in turn also reduces the stimulation to gag. Protection of the endoscopic cord is a major concern during all endoscopic procedures which the current design of the splint amply provides. In long standing treatment procedures of endoscopy, where instruments like cytology brush, biopsy forceps, Sclerotherapy needles and various plungers are carried with the endoscopy tube, the splint provides an excellent aid which not only would benefit the patient but would also allow the operator to focus more on the procedure. The disadvantage with this type of splint may lie in the fact that fabrication of the splint is for one individual and not applicable to all patients.

## 5. Conclusion

Diagnosis and treatment procedures of body recesses like endoscopy can be easily enhanced with fabrication of endoscopic splint like one described in this article. Further refinements in designing as well as studies are required to prove the efficiency, satisfaction and comfort provided by the splint.

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