Summary
Dental caries nearly affects the whole population in one form or another. The formation of a caries lesion starts with acid produced from bacteria metabolizing the sugar in food, this acid provokes dissolution of the enamel and invoke changes in the surface structure of the enamel, such mineral loss will increase the size of enamel pores leading to a decrease in enamels’ mechanical properties, with time this porous enamel starts to breakdown and cavities are formed.

While non-cavitated lesions are considered reversible and classically managed with preventive measures and monitoring, a cavitated carious lesion is deemed irreversible and an operative treatment is required to restore the shape and function of a tooth and to prevent caries progression by removing the infected / demineralized tissue. Moreover a restored cavity enhances the cleaning of the tooth.

With time, most of the non-cavitated lesions progress and are treated restoratively. On long term, restored cavities enter a re-restoration cycle leading to the degradation of the mechanical properties of teeth as well as the long-term prognostic of the dentition, eventually ending by teeth loss. This approach has been the standard method for caries management for decades. The current evidenced-based caries management aims to provide more solid solutions for the early stages of caries to stop its progression into a cavitated state. It is based on biological concepts and involves new approaches in caries detection, assessment, and management.

In this thesis, primarily proximal non-cavitated carious lesions in molars and premolars are the main topic of interest as these lesions present a real challenge for the dental practice. Since visual detection of such lesions in virtually impossible, bitewing radiography have been widely used to detect proximal caries since their introduction in 1925. Beside the known disadvantages of radiography, like underestimation of actual lesion size, it must be kept in mind that it still is applying ionizing radiation, which can have
undesirable side effects to the human body. Moreover, repetition of radiographs for monitoring lesion progression or detecting new lesions is not very effective for monitoring caries in young patient with high risk of developing caries. Yet, by a lack of alternatives, clinical examination supported by radiography became the gold standard on which the dentists all over the world relies their dental treatment choices.

Alternative methods have been described, light transillumination for instance is one of the oldest methods for caries detection. In their attempt to find the best wave length “optical window” for dental tissue transillumination, researchers introduced near infrared transillumination around 20 years ago. It has been found that this enabled the detection of early enamel lesions before any cavity formation.

With the recently developed caries management methods we know that non-cavitated enamel lesions can be sealed and/or infiltrated with resin, this treatment will transfer the demineralized enamel to a hybrid enamel/resin substrate and make it resistant to acid, thus preventing the lesions progression. Unlike on radiographs, proximal lesion progression can be monitored by near infrared transillumination when the lesion is still in enamel.

Using this non-invasive approach in early detection and treatment, dentists will intervene at the right moment and this help maintain natural teeth for life.

The purpose of the studies presented in this thesis was to examine the current available evidence on near infrared transillumination to detect early proximal enamel lesions.

It also portrays the current evidence related to the efficacy of new caries management methods to arrest or slow down the progression of such lesions using infiltration and sealing and goes into the advantages and disadvantages of each.
Moreover, this dissertation-project investigates an alternative method combining infiltration and sealing to overcome the disadvantages of each technique and provides a scientifically based protocol for a non-invasive proximal adhesive restoration of early proximal lesions.

Conclusions from this thesis are that:

1) proximal caries detection can be achieved using near infrared transillumination in an earlier stage than what usually is found on radiographs.
2) Non cavitated proximal lesions infiltration can be achieved using one component resin adhesives after proper enamel pretreatment.
3) Enamel pretreatment using an abrasive strip and phosphoric acid provides an enamel surface infiltratable with one component adhesives.
4) combining the infiltration with sealing may provide a double protection of the lesion surface while infiltrating the lesion in a similar way as the marketed resin infiltrant ICON.
5) the technique of NIPAR is applicable in the clinic and the results from the cases presented in the last chapter are promising and encourage a long term clinical study.

Providing a non-invasive alternative to the classic caries detection and management approach, this thesis aims to support and encourage the paradigm shift of the actual practice of early caries management and promote early non-invasive interception to help maintain natural dentition for life.

The paradigm shift is based around 2 main points; non-invasive early detection and non-invasive early intervention. It must be stressed that to apply the concepts discussed in this thesis, practitioners must embrace both changes in detection and in management. Adopting early detection while continuing the classic management approach will lead to overtreatment of
early lesions, while applying new management options to lesions detected on x-ray will lead to miss-treating advanced lesions and increasing the chances of early non-invasive treatments failing.