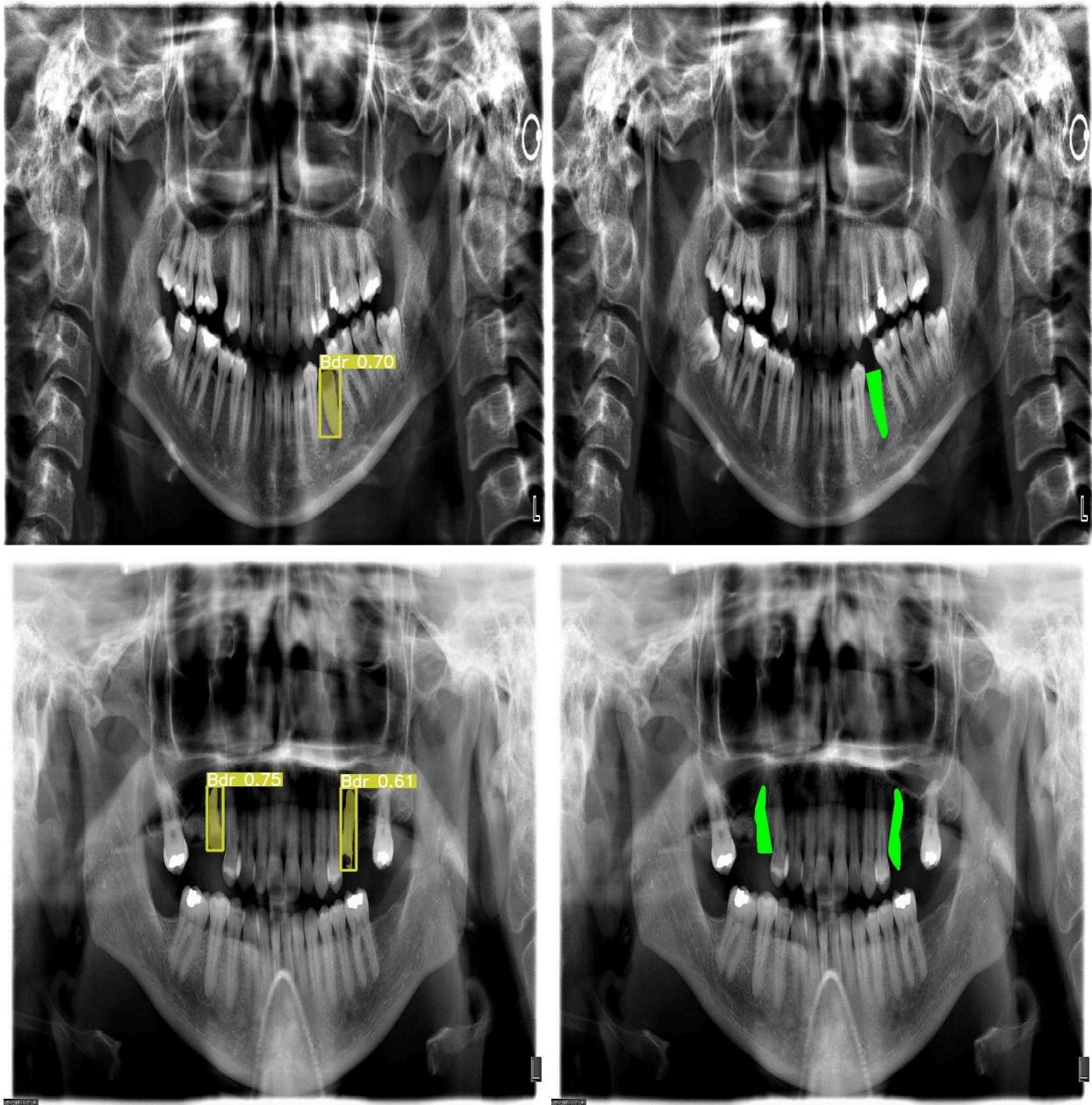
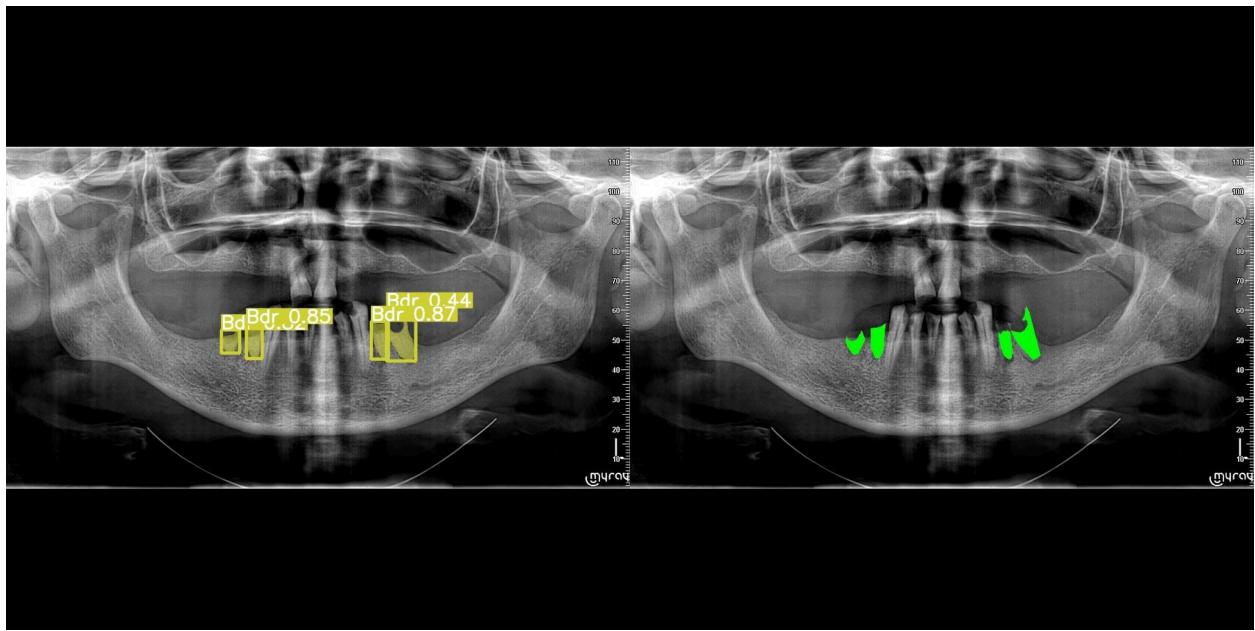


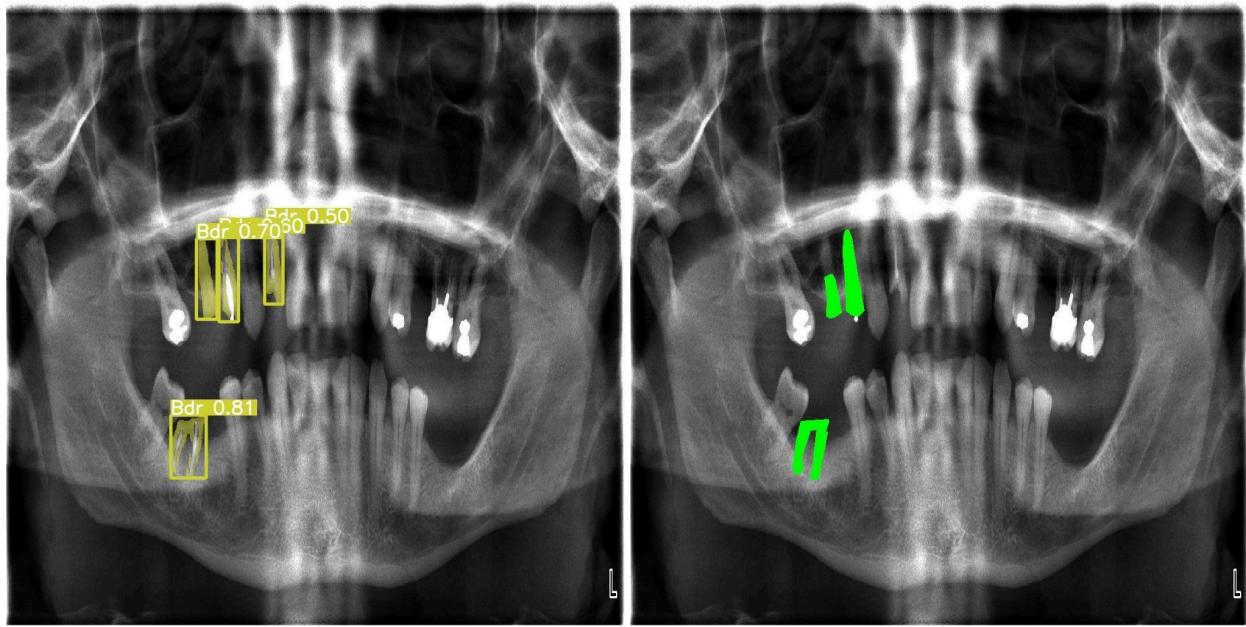
Bdr
Test Data

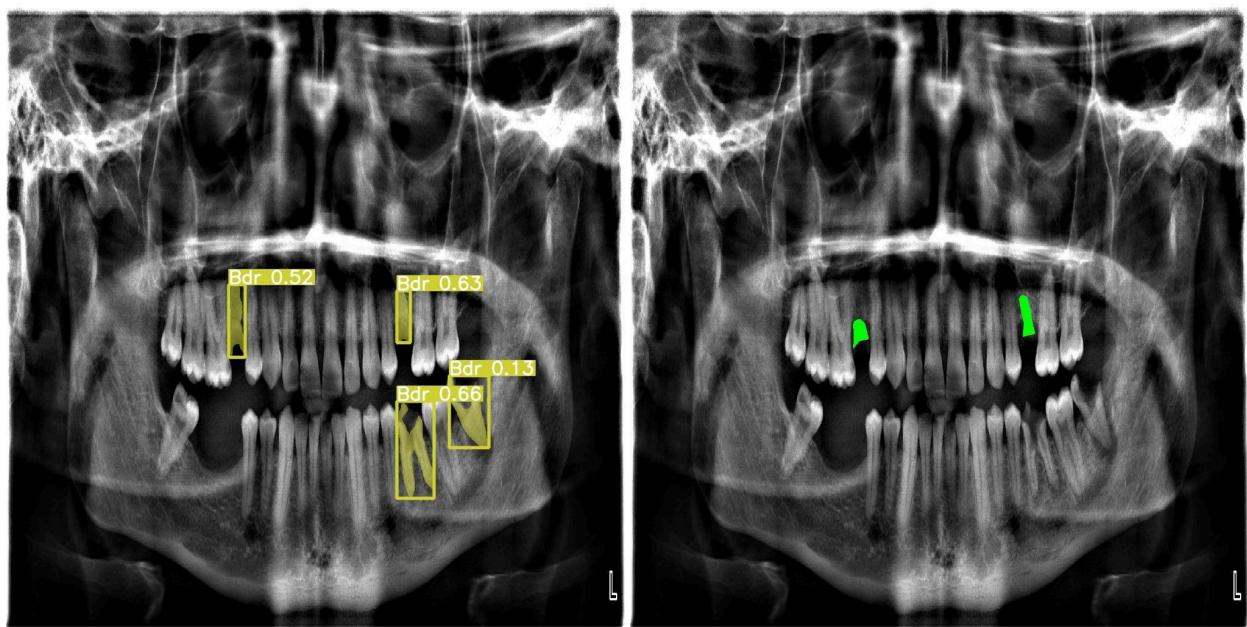
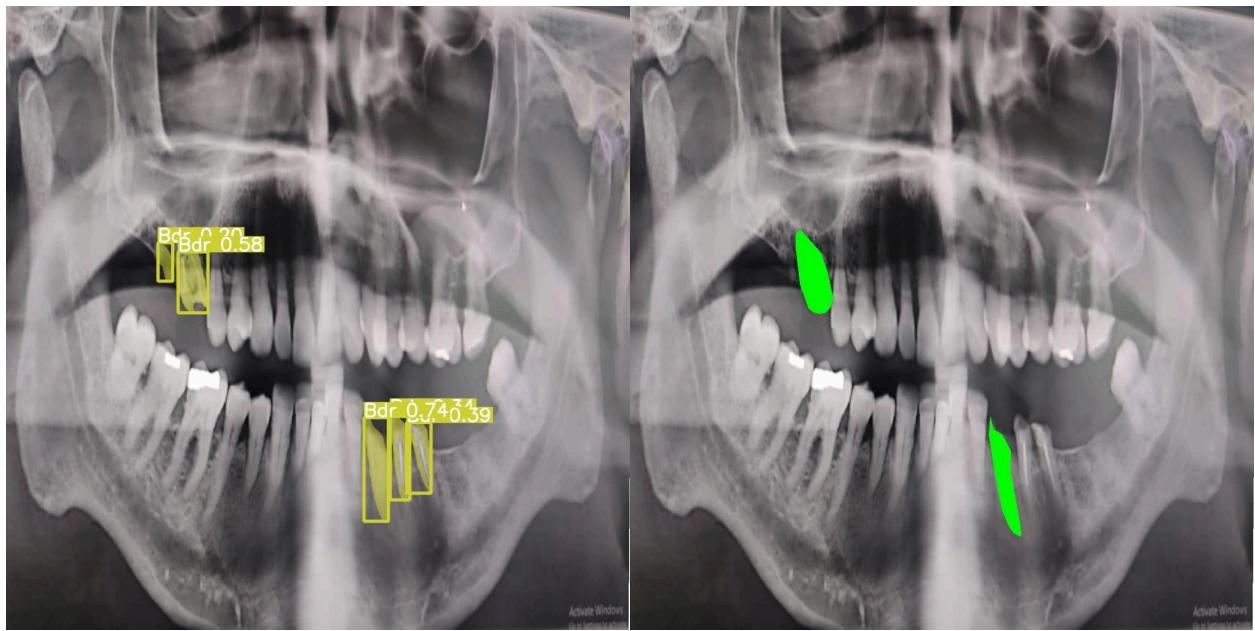
It appears that the model is able to predict the class with some confidence. Examples of such predictions can be shown below

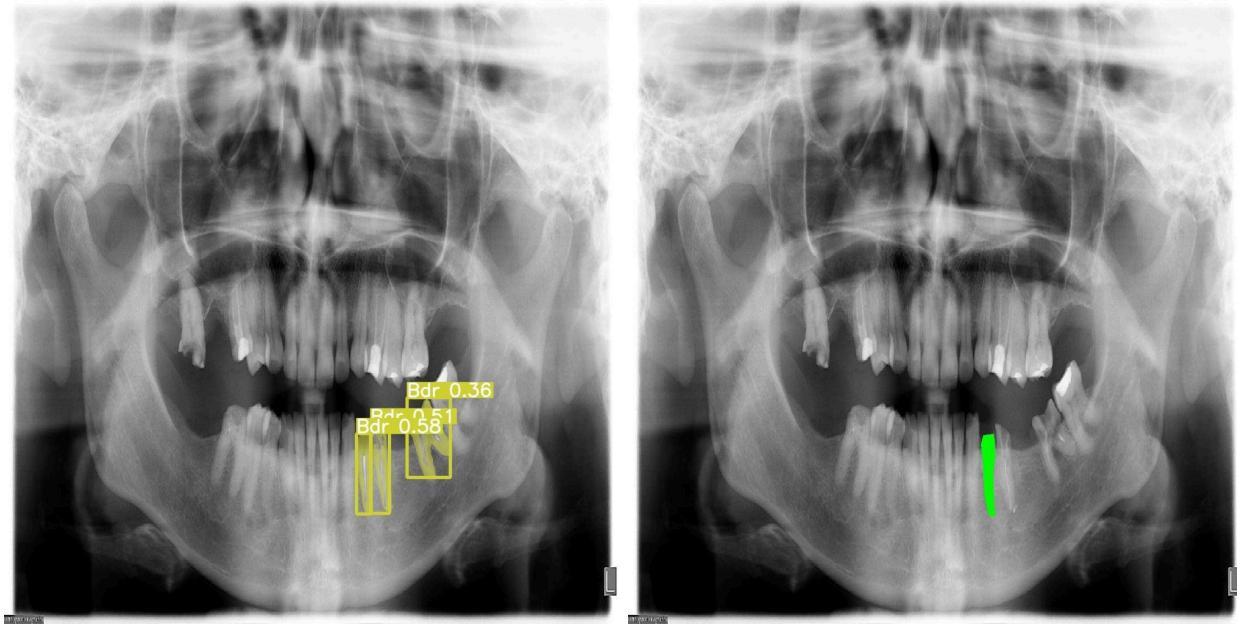




However, the model makes several mistakes with bdr. Teeth that have been affected by caries or have root canalizing done tend to be classified as bdr. Examples of such include

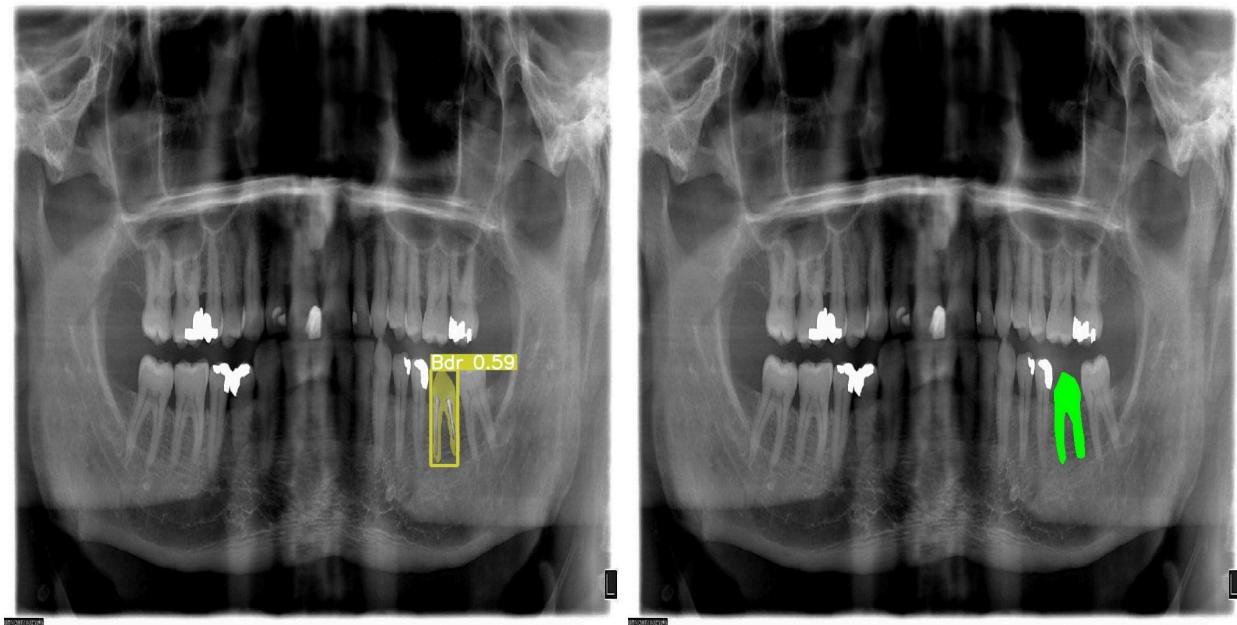


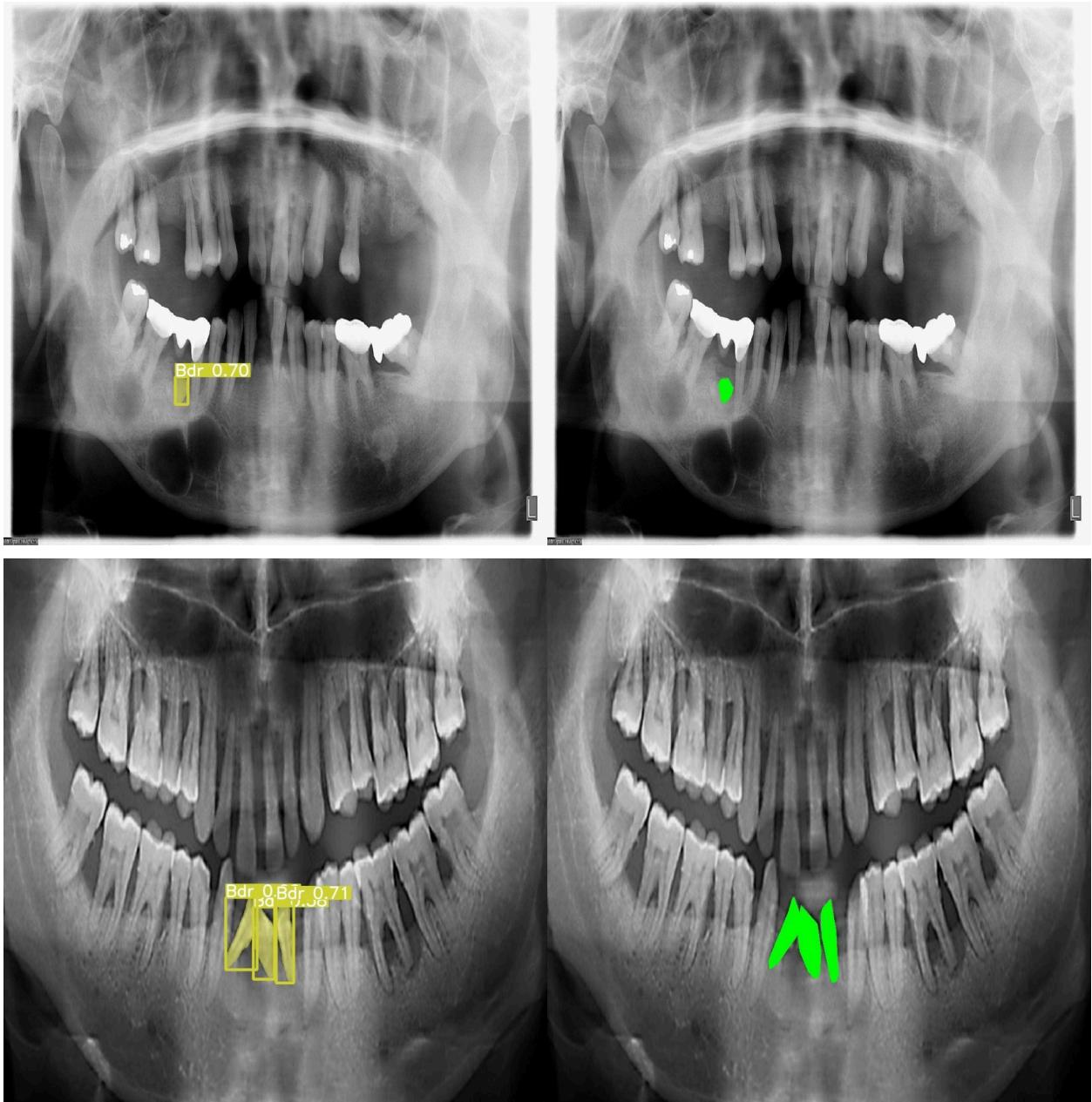




Train data

Bdr appears to be correctly predicted with good confidence on train data. Results can be seen in train data uploaded. Below are a few examples

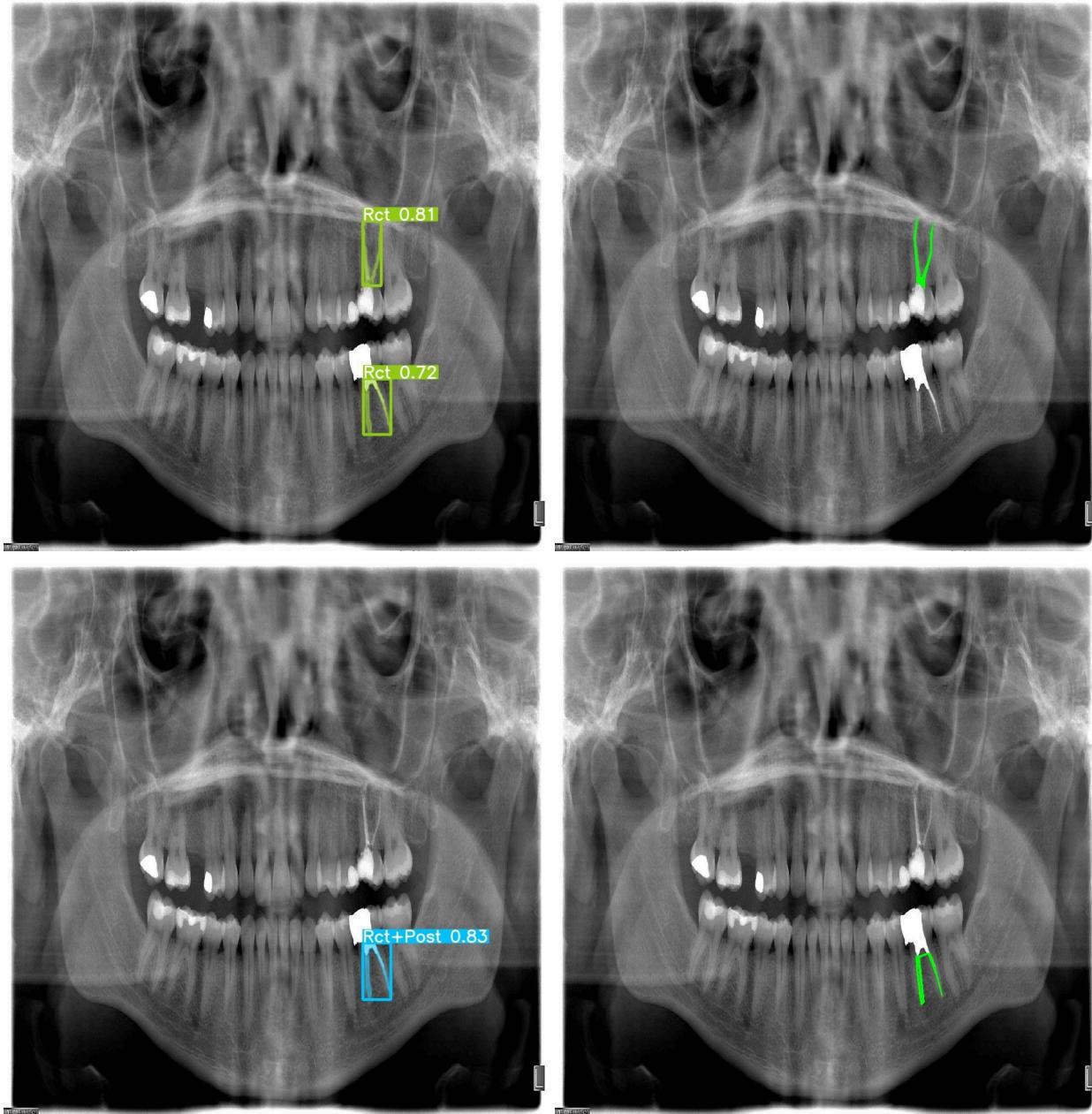




The image above highlights an issue, 1 bdr object is depicted as two bdr objects by the model.

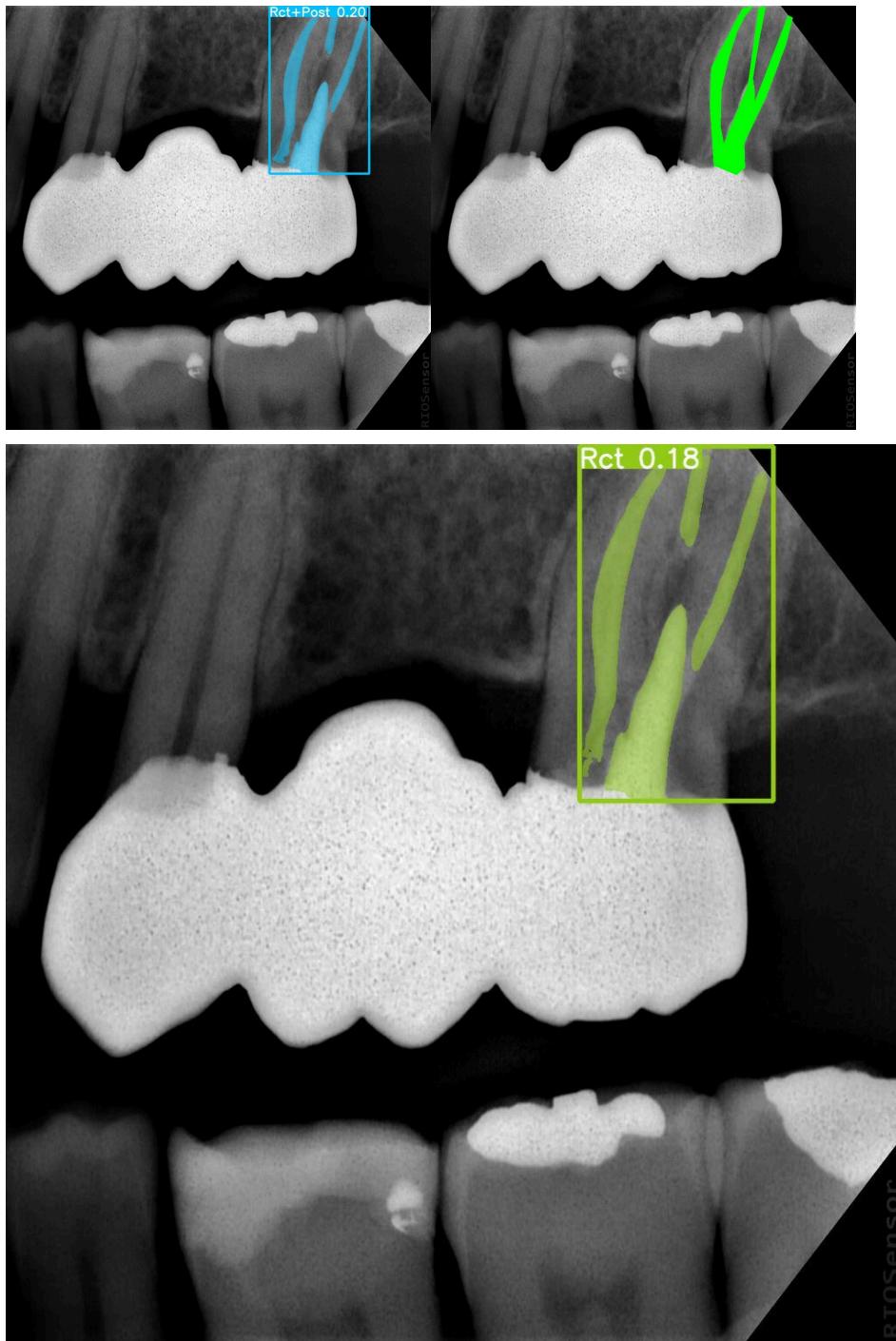
Rct, Rct+post

The biggest problem with Rct, and with Rct+post is that the two classes look similar to each other.



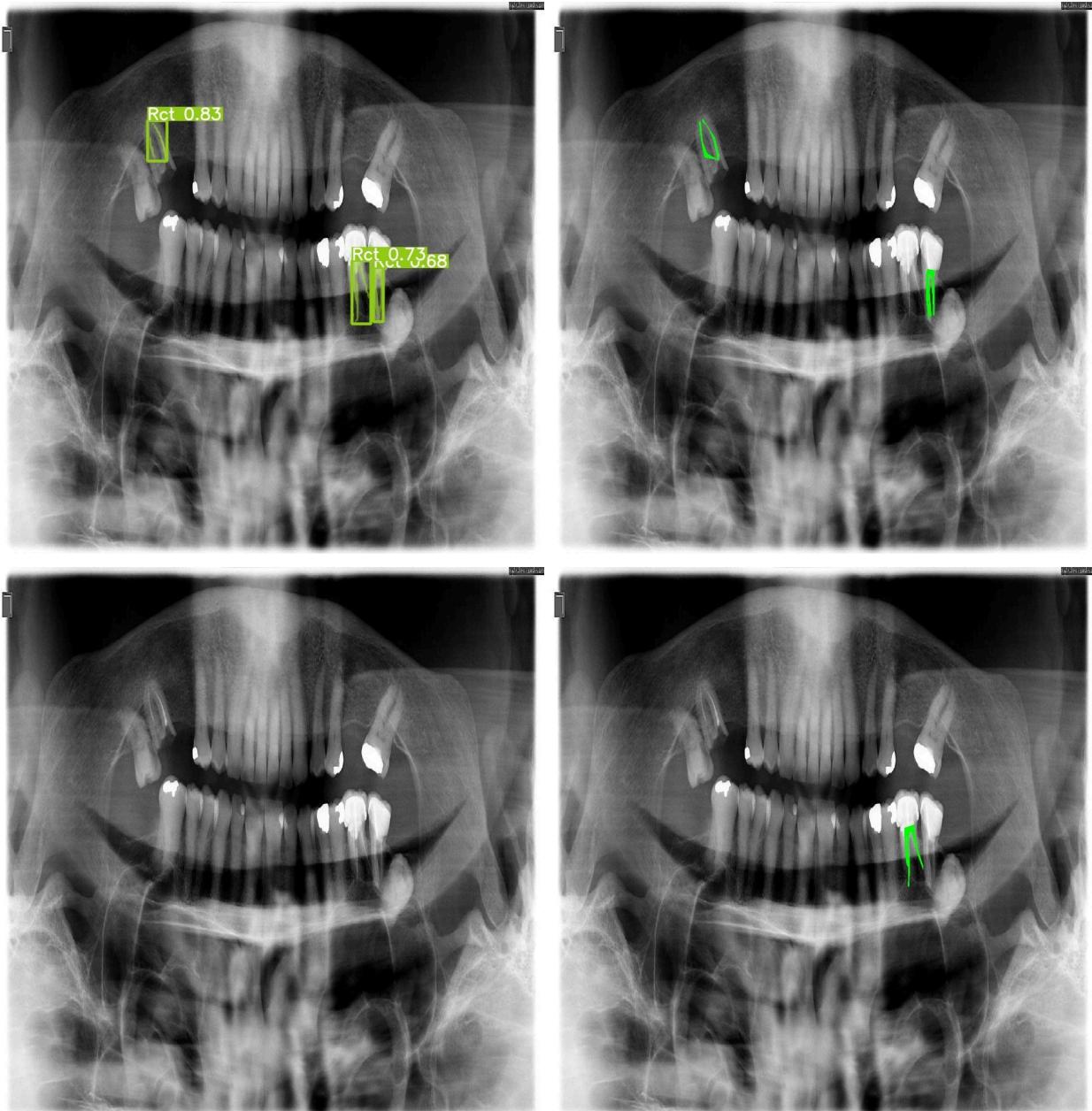
In the above example from the test dataset, you can see that an object that in the ground truths is rct+post, and while it is classified as Rct+post with a high confidence score of 0.83, it is also classified as Rct with a high confidence score of 0.72

Another such example would be this



Some sort of post processing algorithm would have to be made because you are going to see objects that will be labeled as both Rct and Rct + post. The object with the lower confidence would have to be removed.

On occasions, you see this sort of result,a Rct +post missed, and classified as Rct

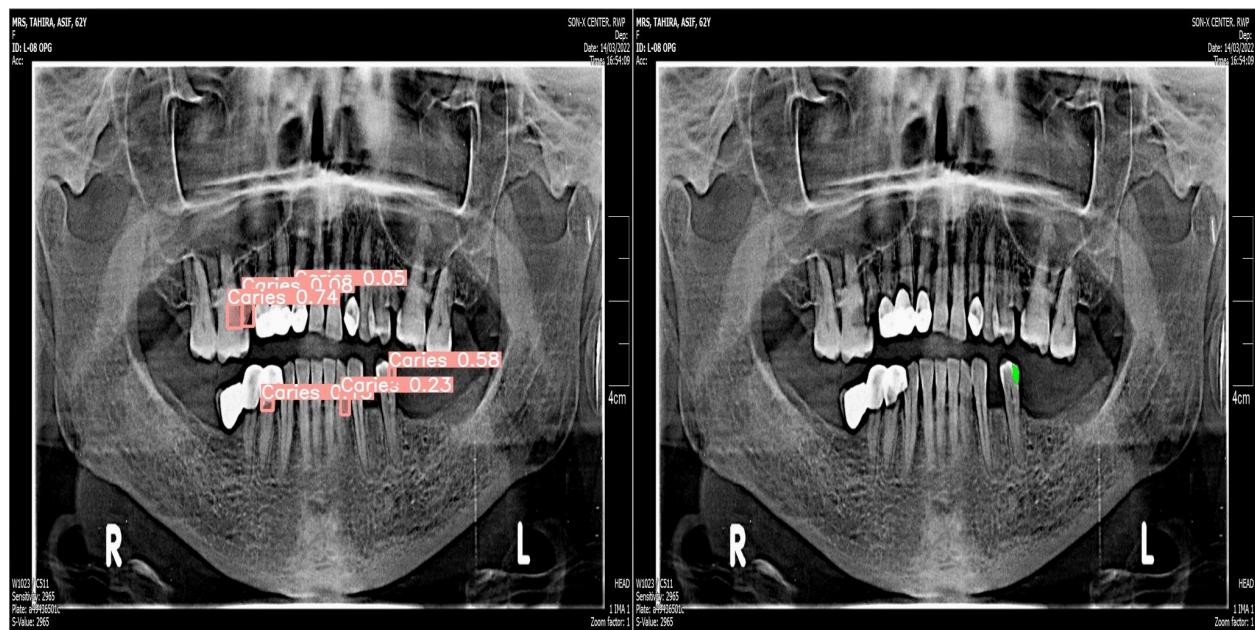
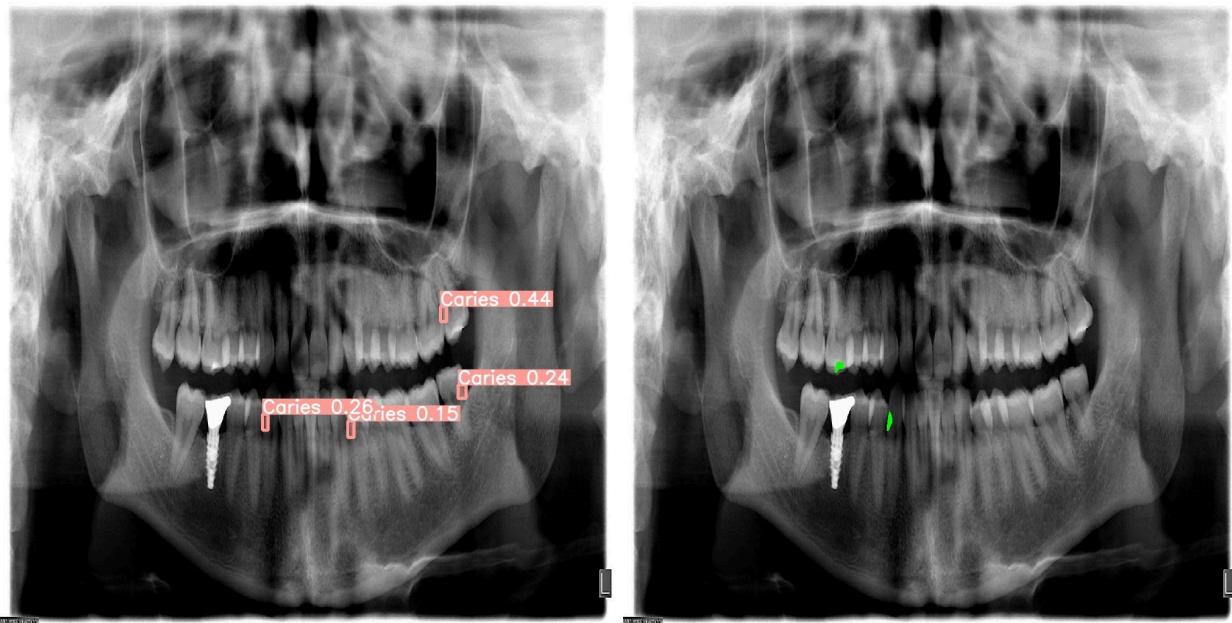


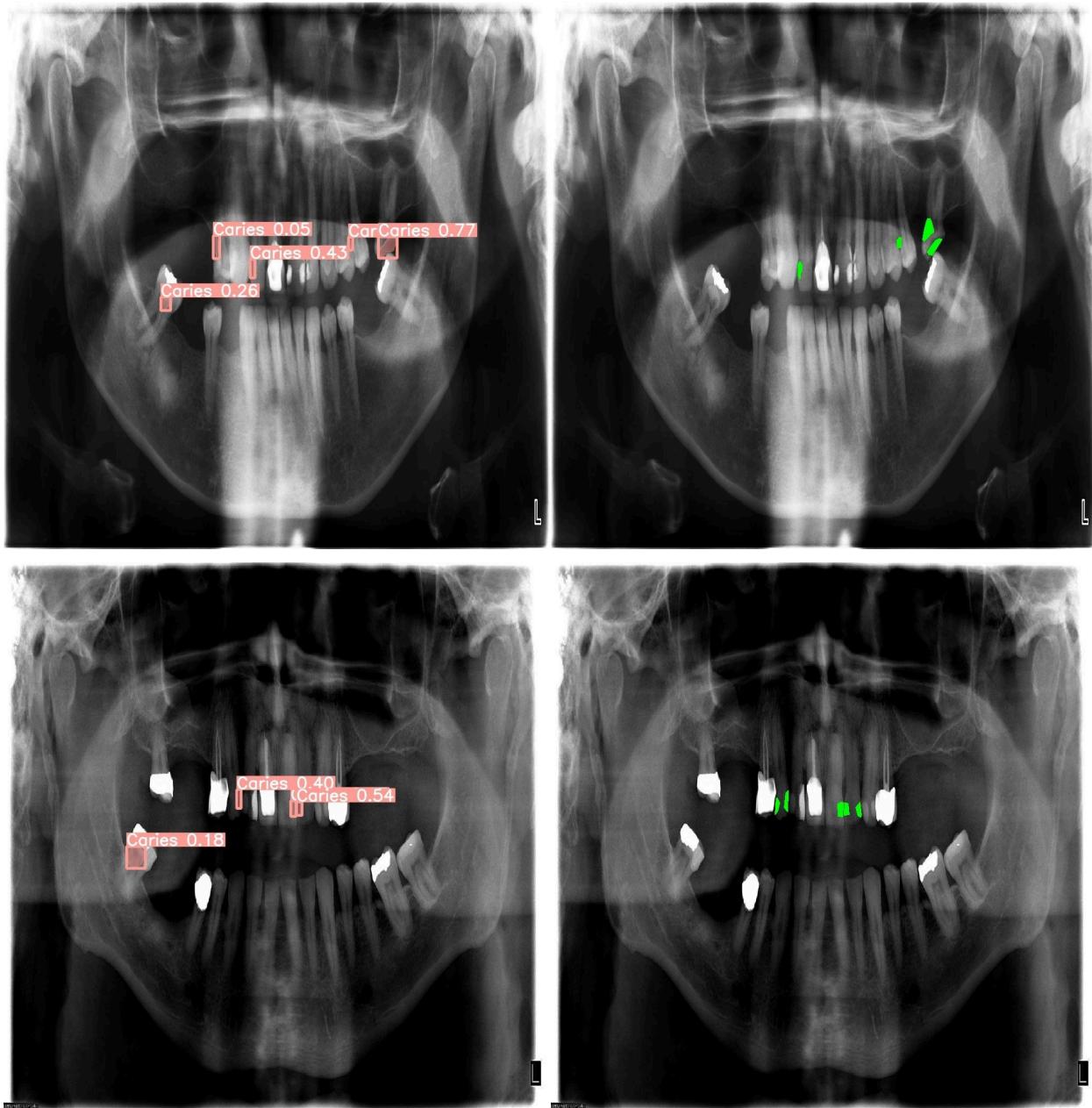
The image above shows the ground truth of rct+post missing and classified as Rct instead. This sort of issue is possibly because of class imbalance in the training dataset. Rct is a lot more common than Rct+post, comprising around 6.74% of all objects, compared to 2.04% of Rct+post

Caries

Test Data

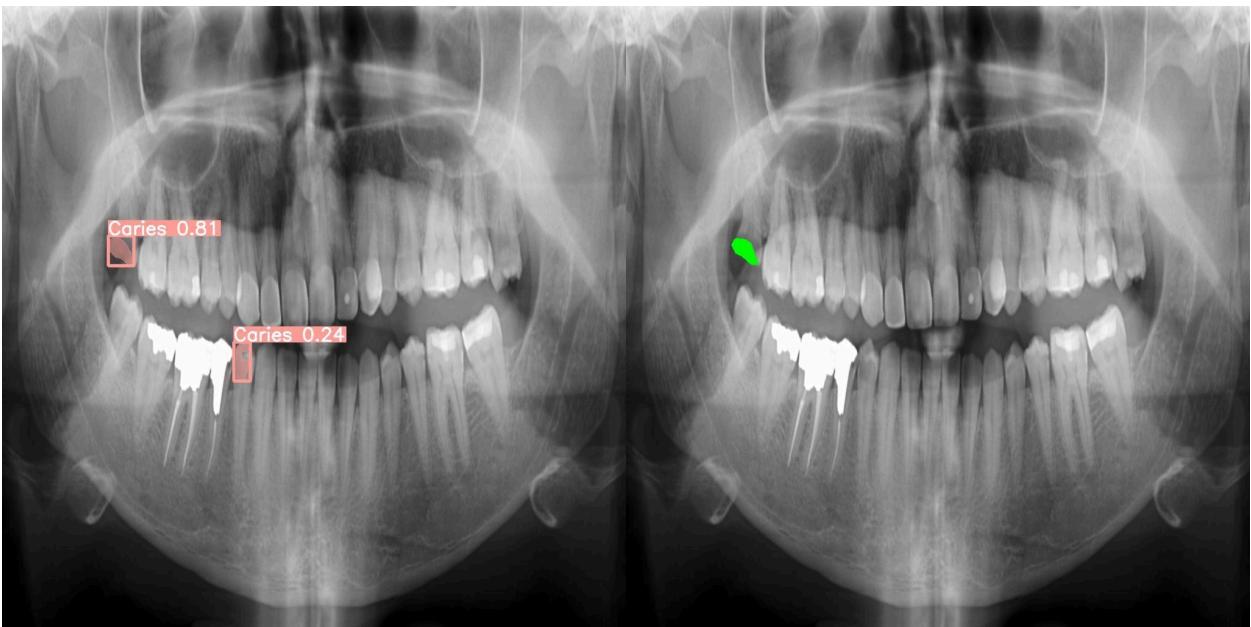
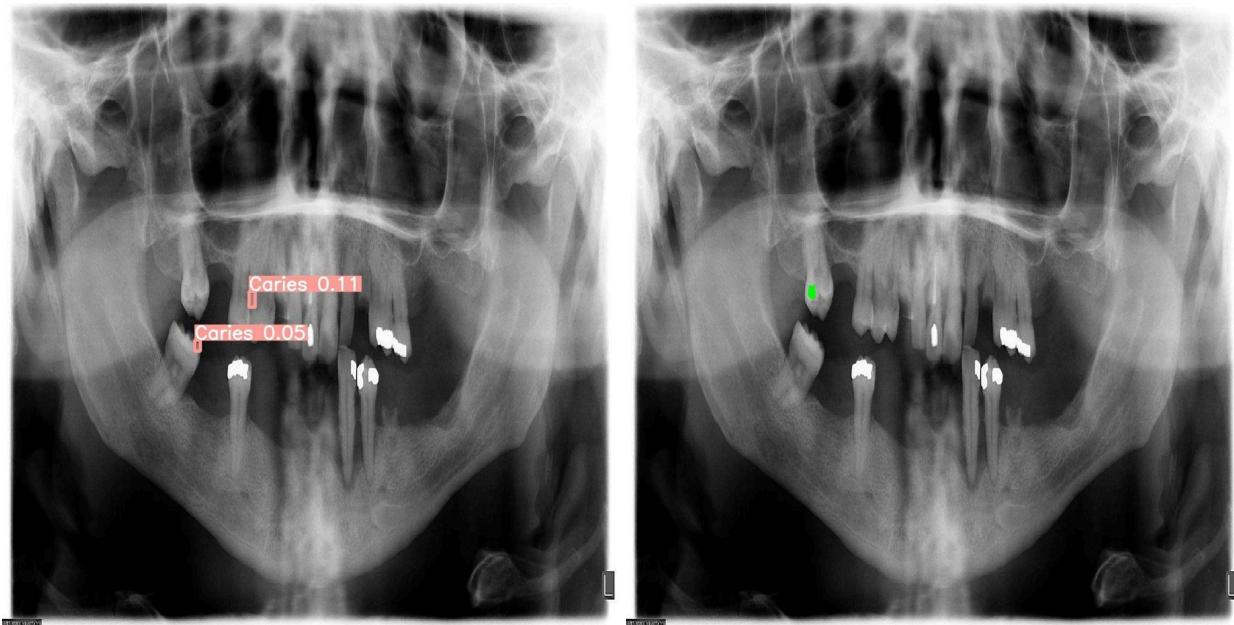
Results are not good with low confidence

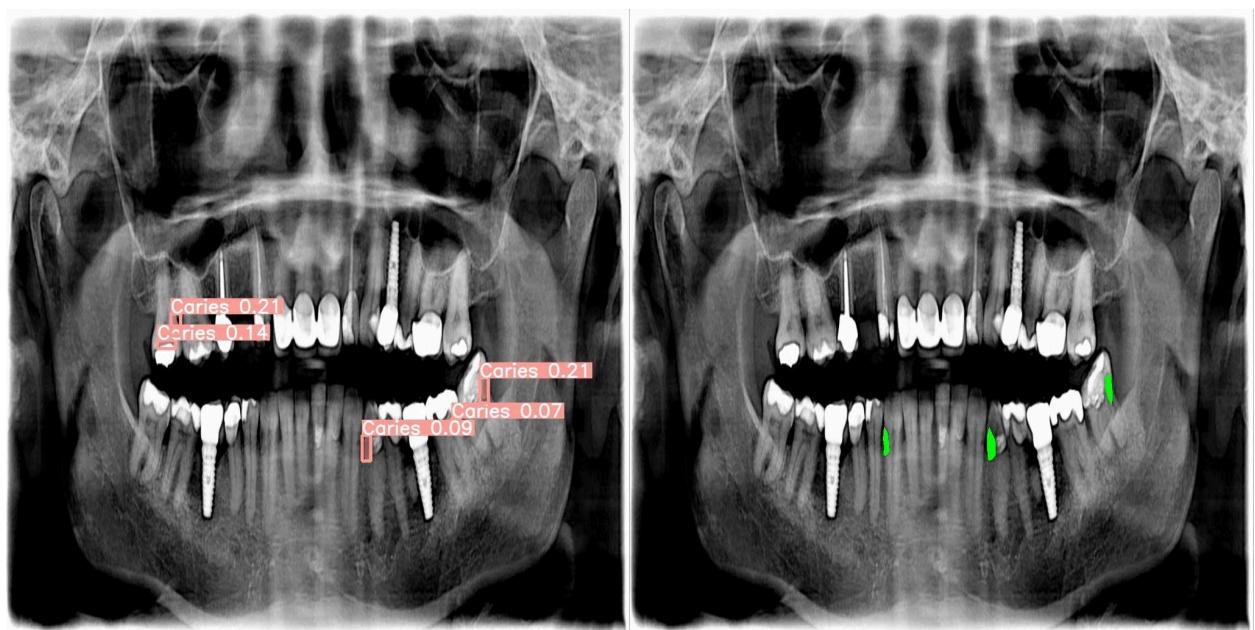
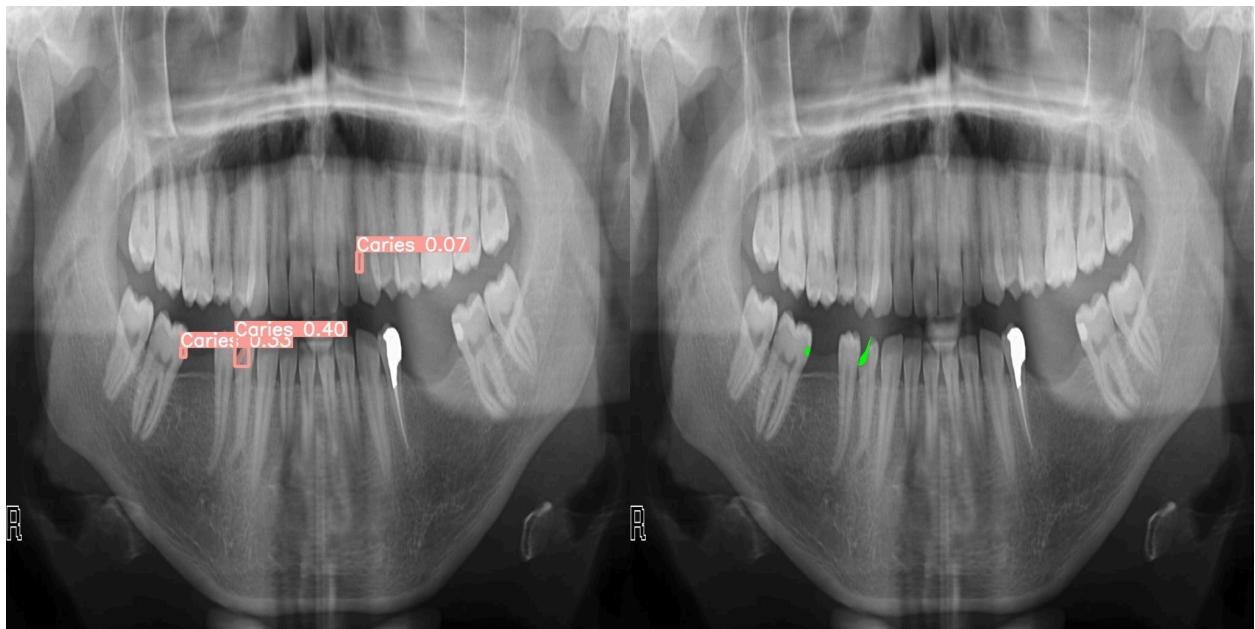




Train Data

Also disappointing

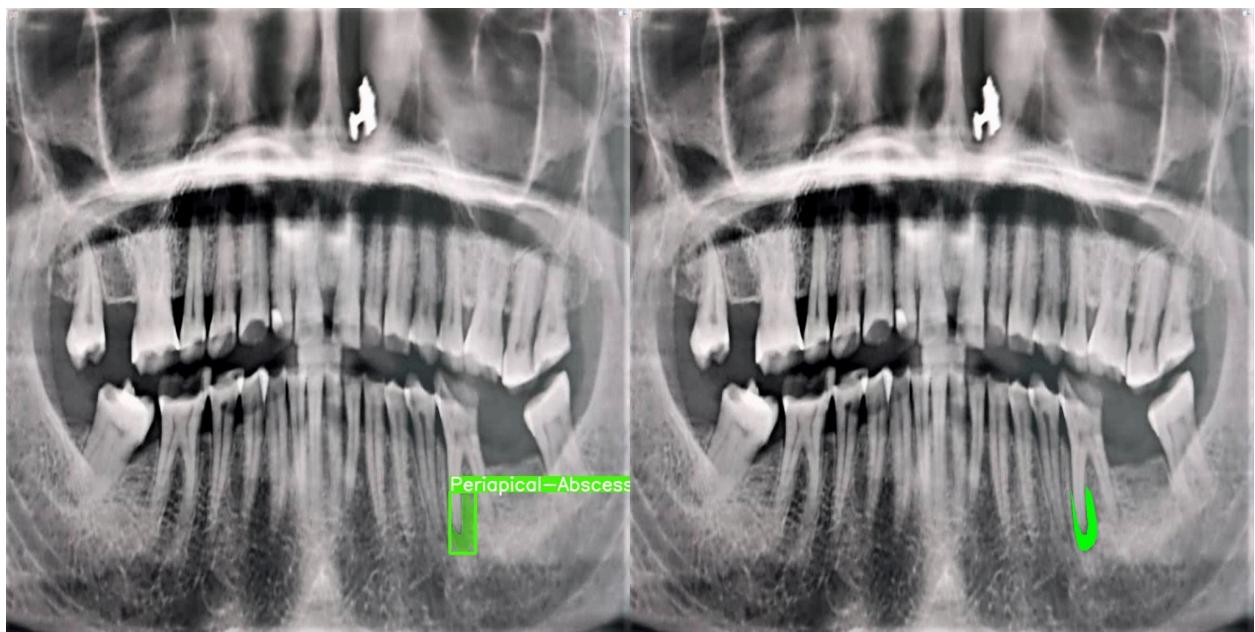
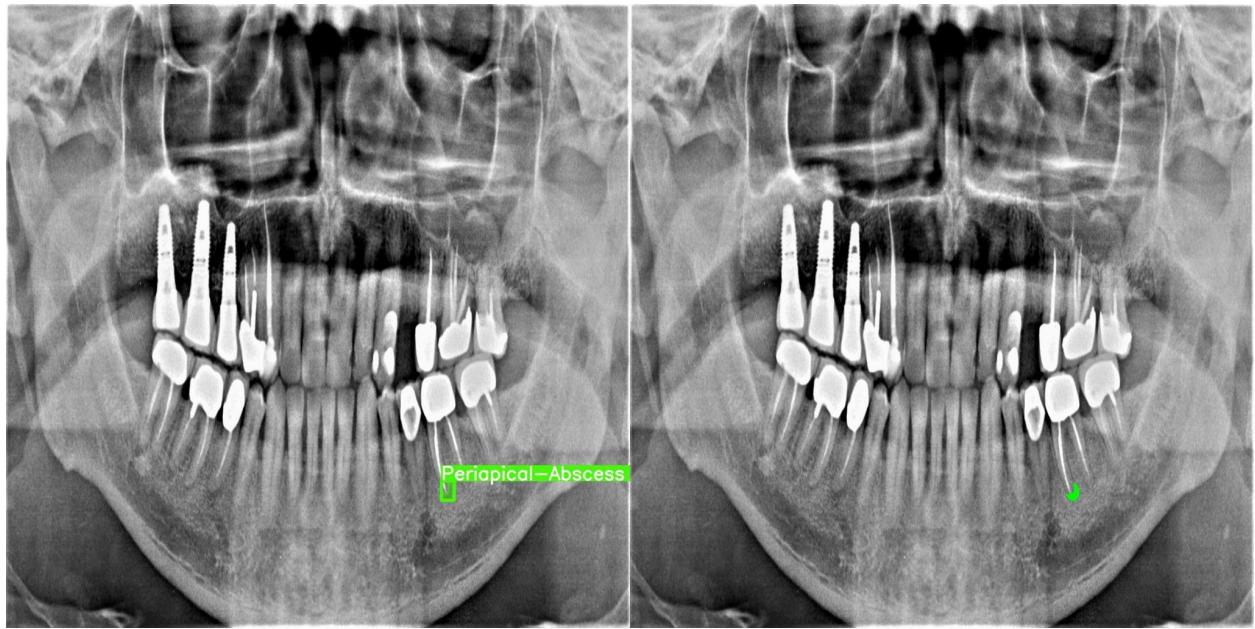


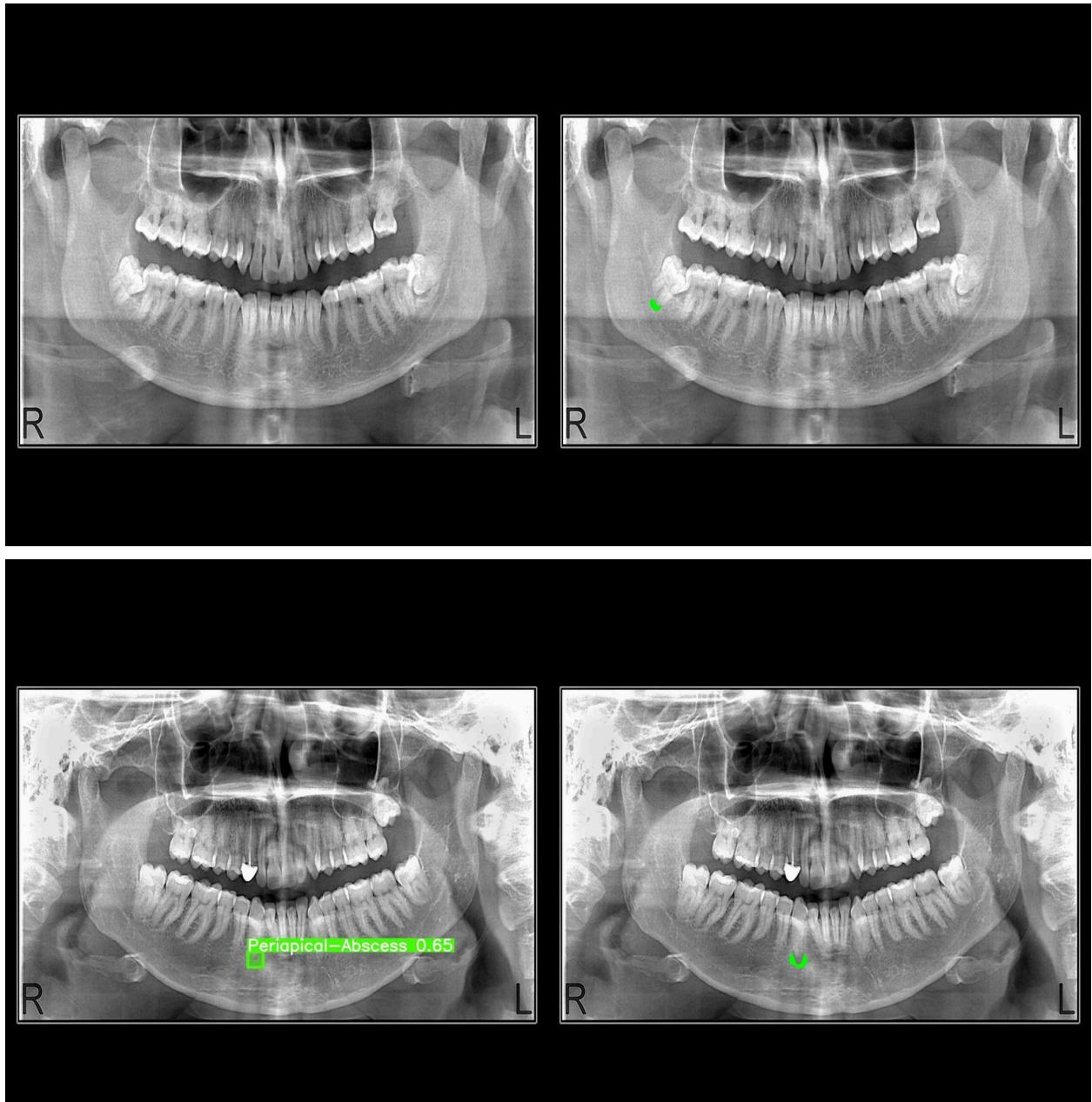




Caries results are poor in both train and test data, the model is unable to learn what caries looks like. This is a combination of inconsistent annotations, and well other issues, such as small object sizes, and similarity between object and background. You have a darkish object that has a dark background and image quality varying, you have a mixture of jpg and png images, that might be compounding the problem. What can be done is to have a more tooth centric approach, at least it would help fix the small object problem. Zoom into areas of interest in the image, annotate those regions and pass it to a classifier. It would probably also help fix the rct and the rct+post problem. It would be easier to do segmentation if the objects are larger.

Periapical abscess
Test data

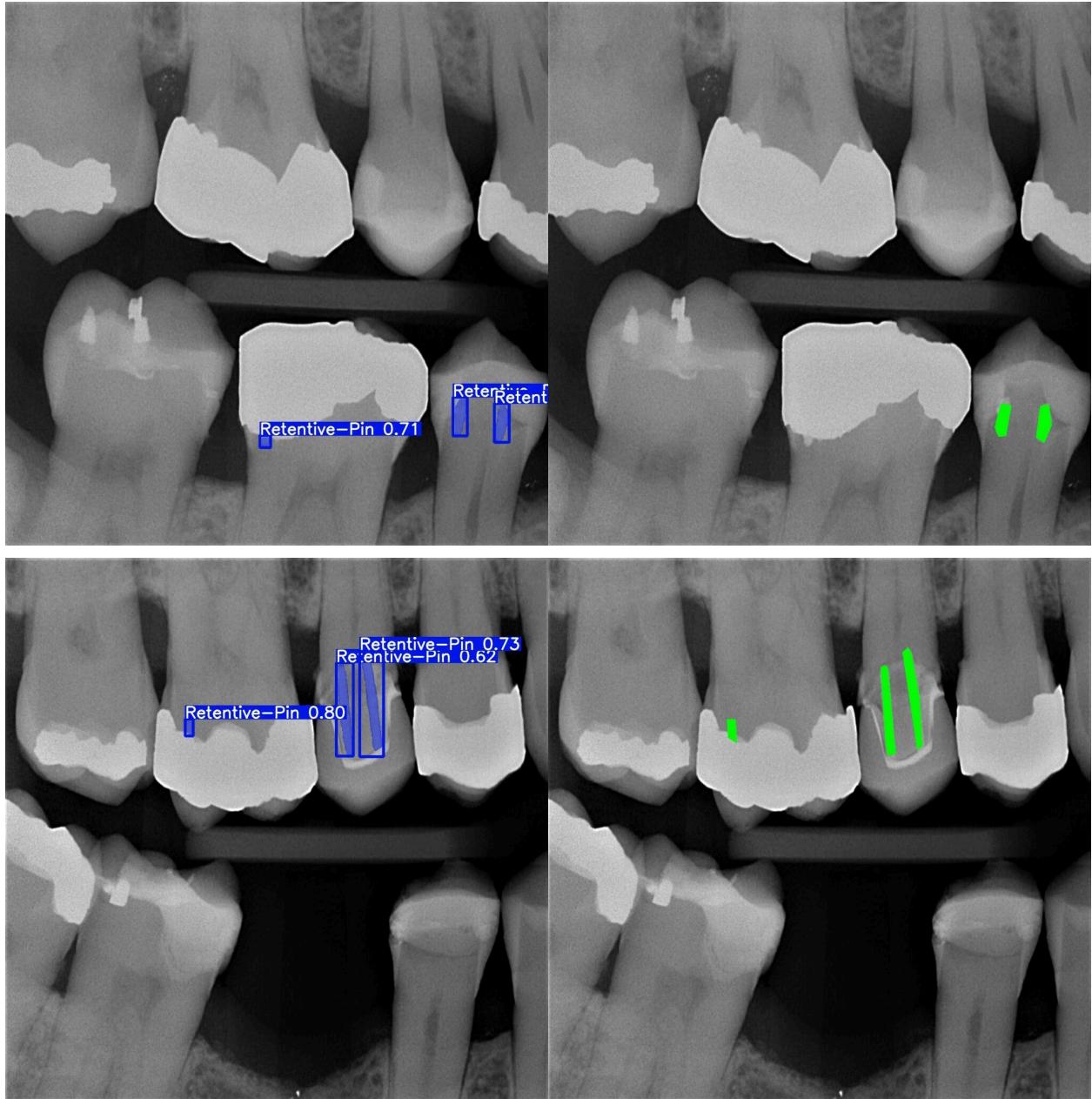


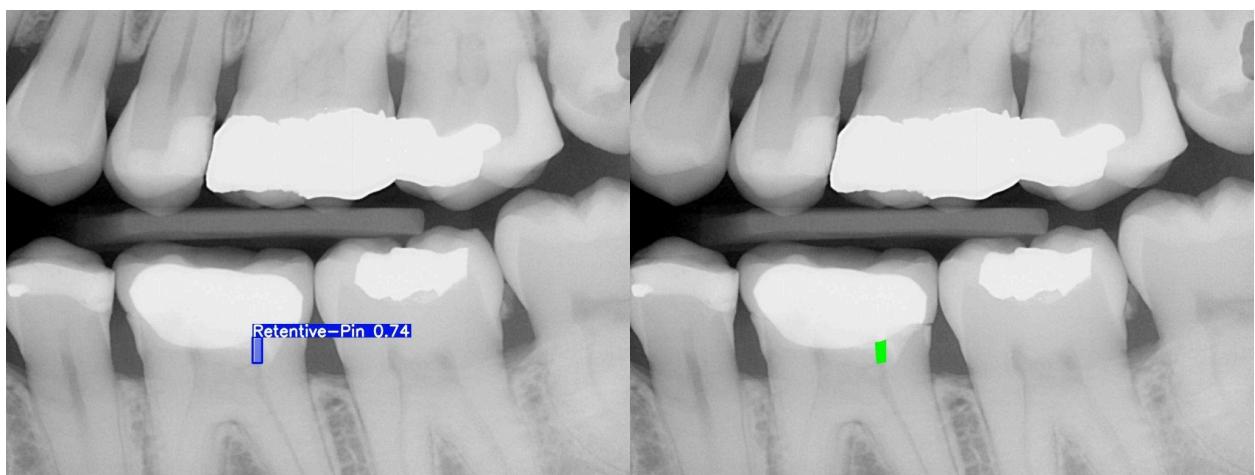
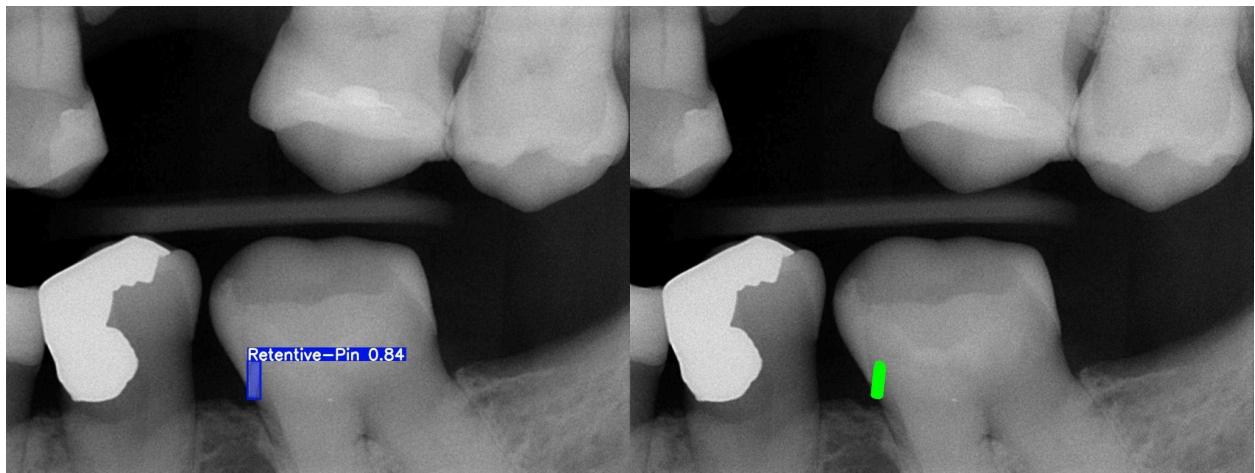


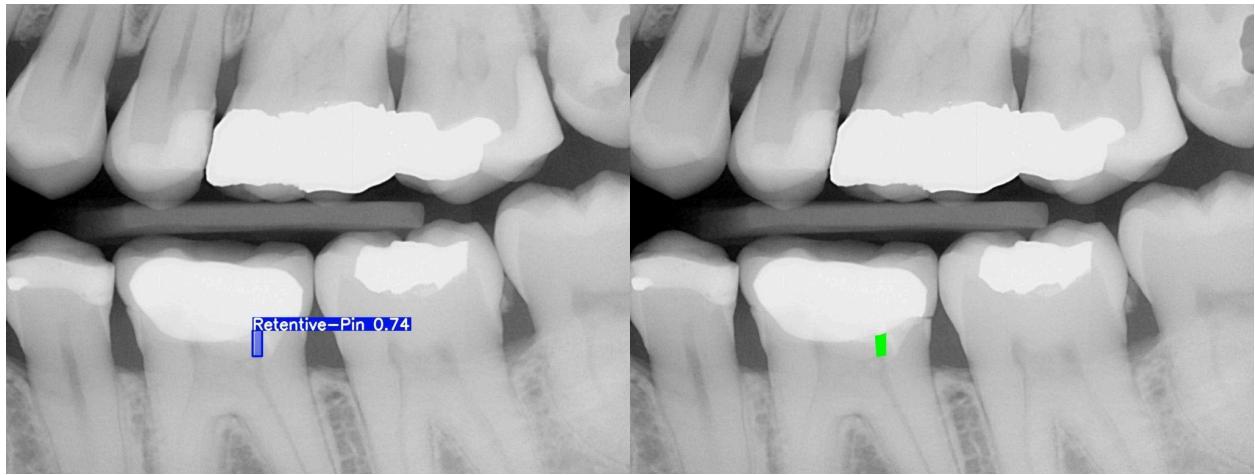
Model appears to learn to detect periapical abscess as compared to caries, as can be seen above. In some images, the model fails to detect it, again, a darkish small object behind a dark background is making this difficult. Detection of periapical abscess appears to be better than caries because of consistency of labeling and an understanding of the location of it, i.e on the bottom edge of the tooth, whereas, caries can be located all around it. The problem with periapical abscess detection is again, small dark objects with a dark background, and a lack of data. More data, and a more tooth centric approach to segmentation would probably improve results.

Retentive Pin

Test data

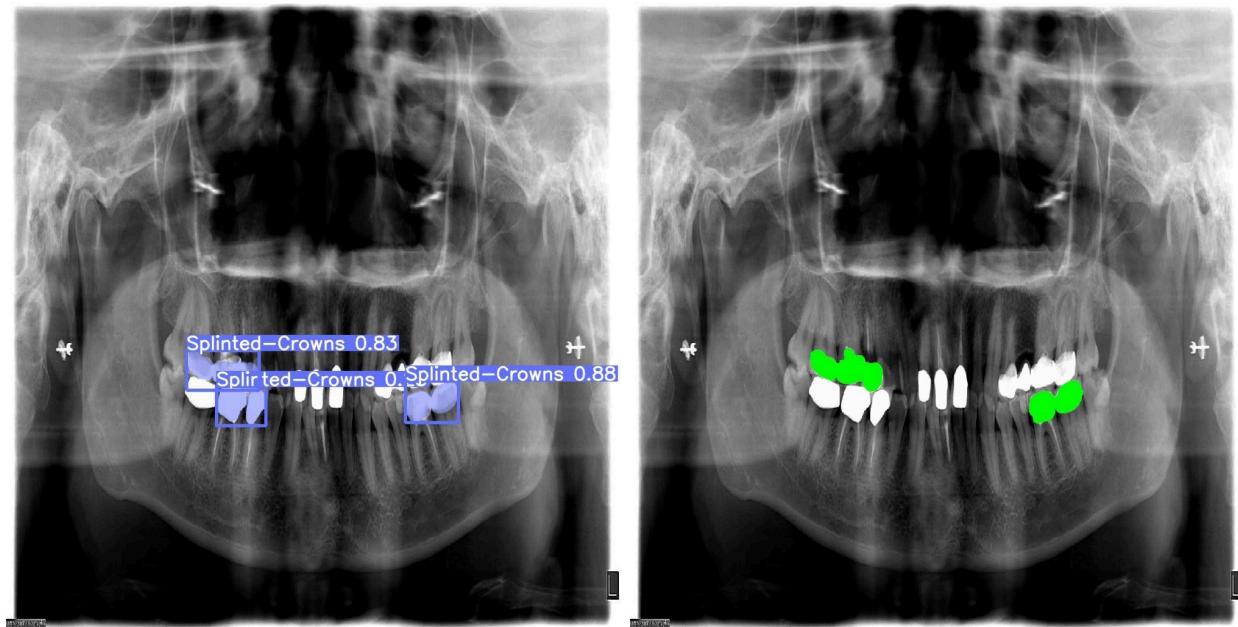


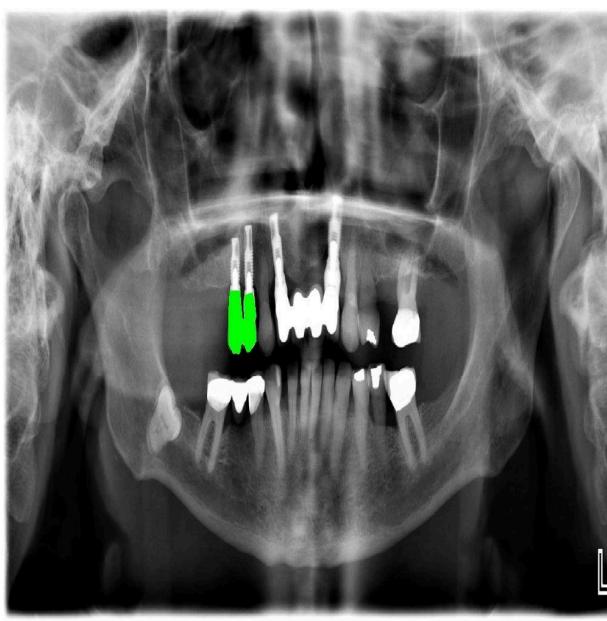
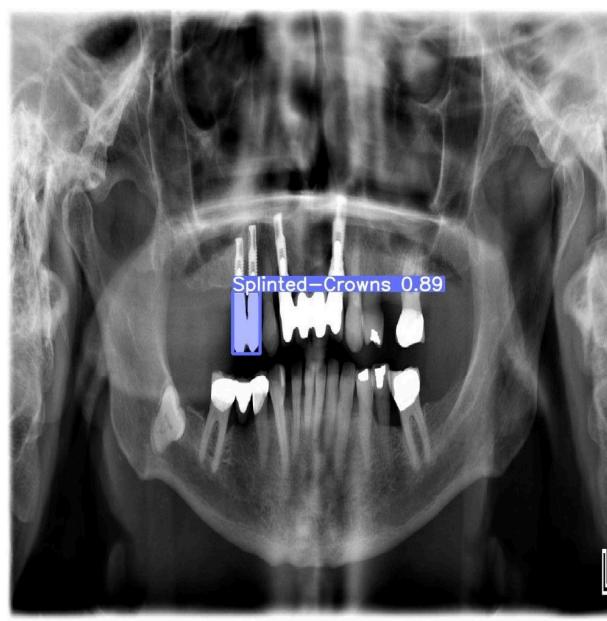
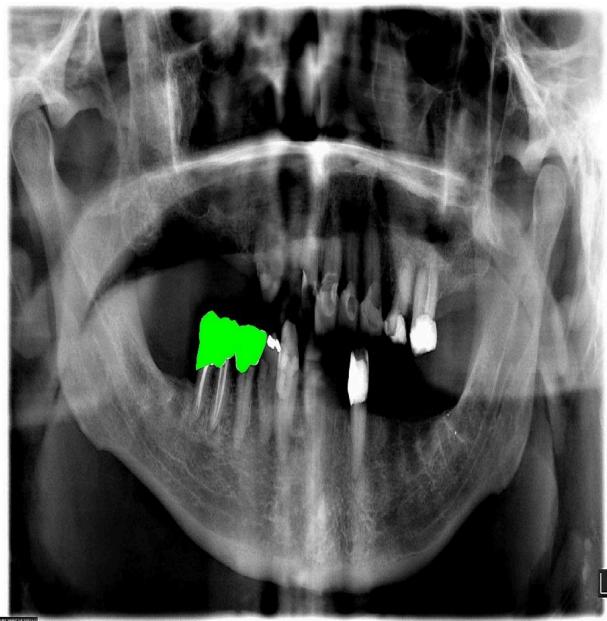
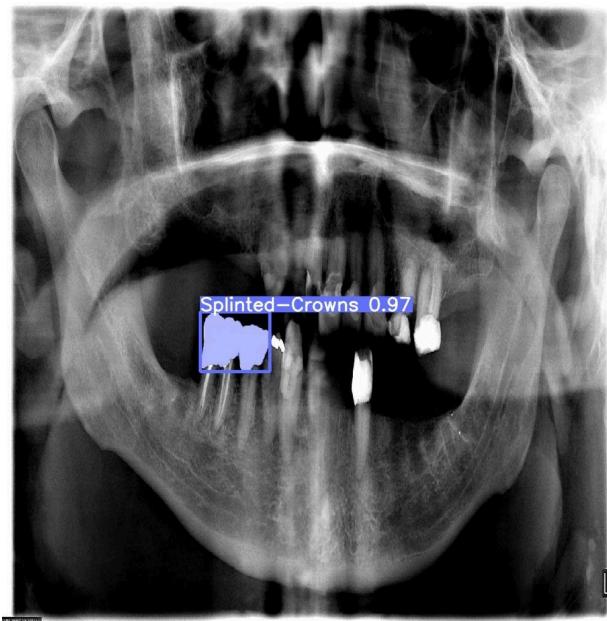


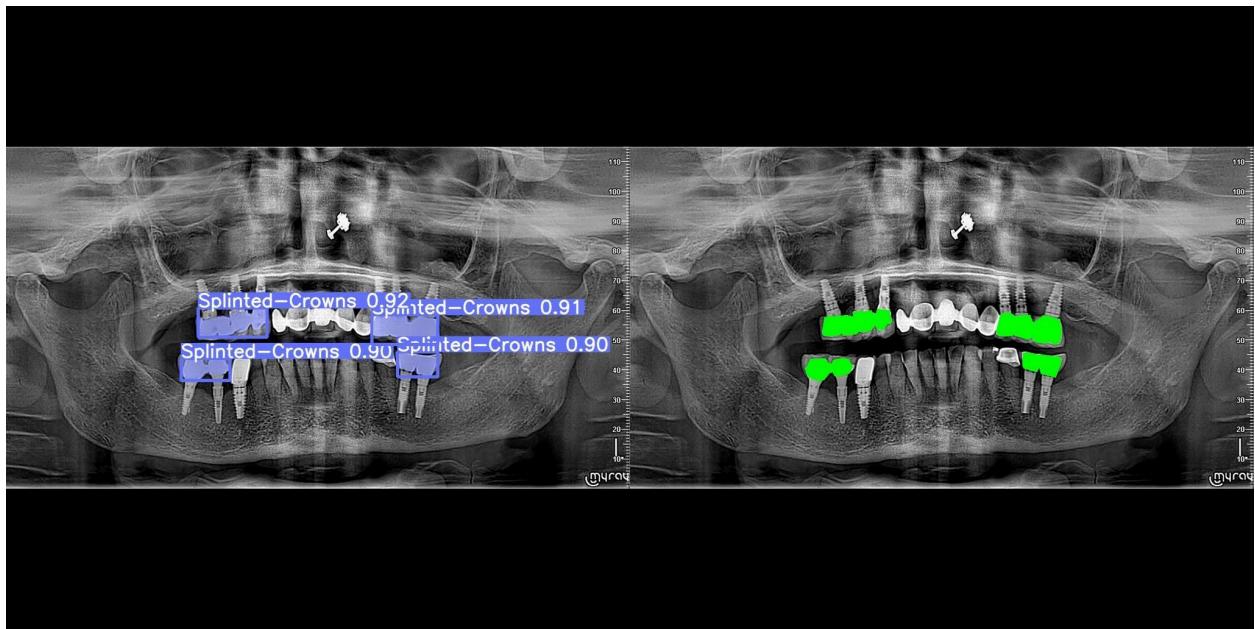


Model appears to do alright on retentive pin, better than periapical abscess, because despite its small size, it is a white object with a dark background, next to a much larger white object, which the model is able to learn. Issue with the class is a lack of data. Would need more instances of the class to improve its accuracy.

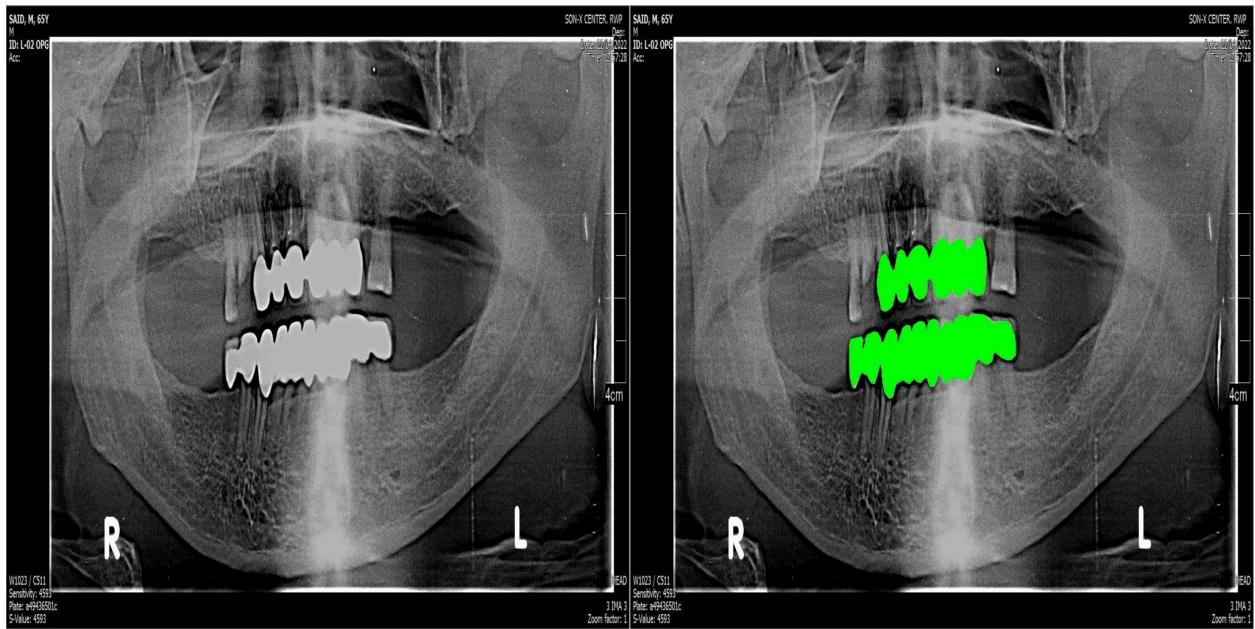
Splinted Crowns
Test data

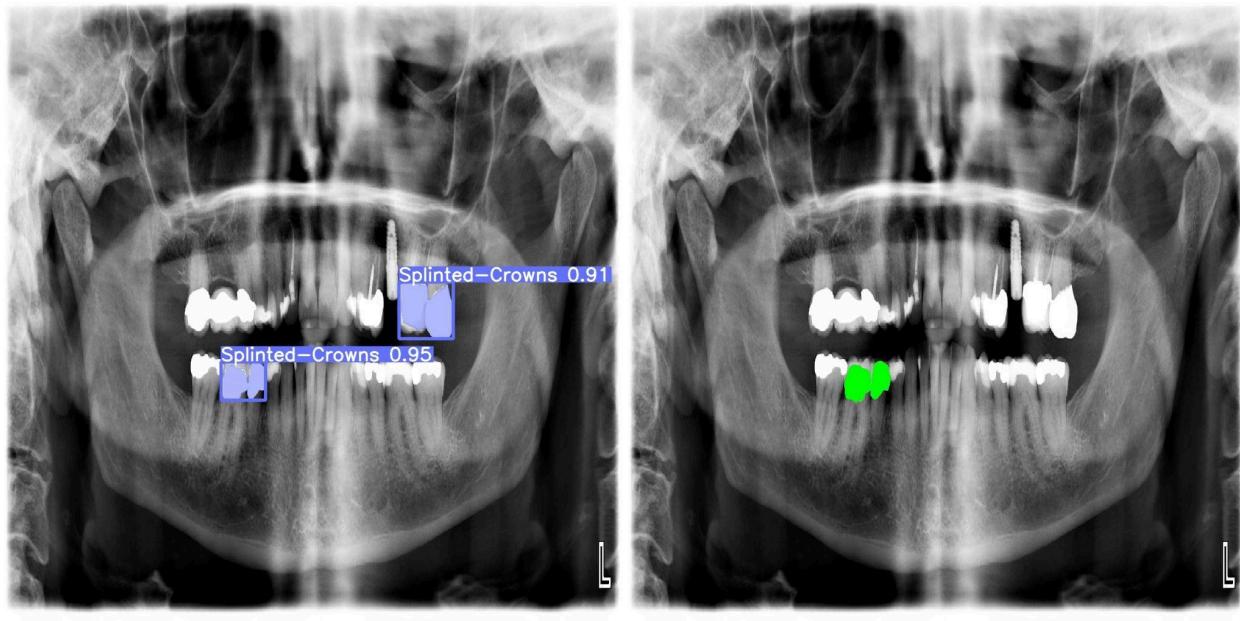






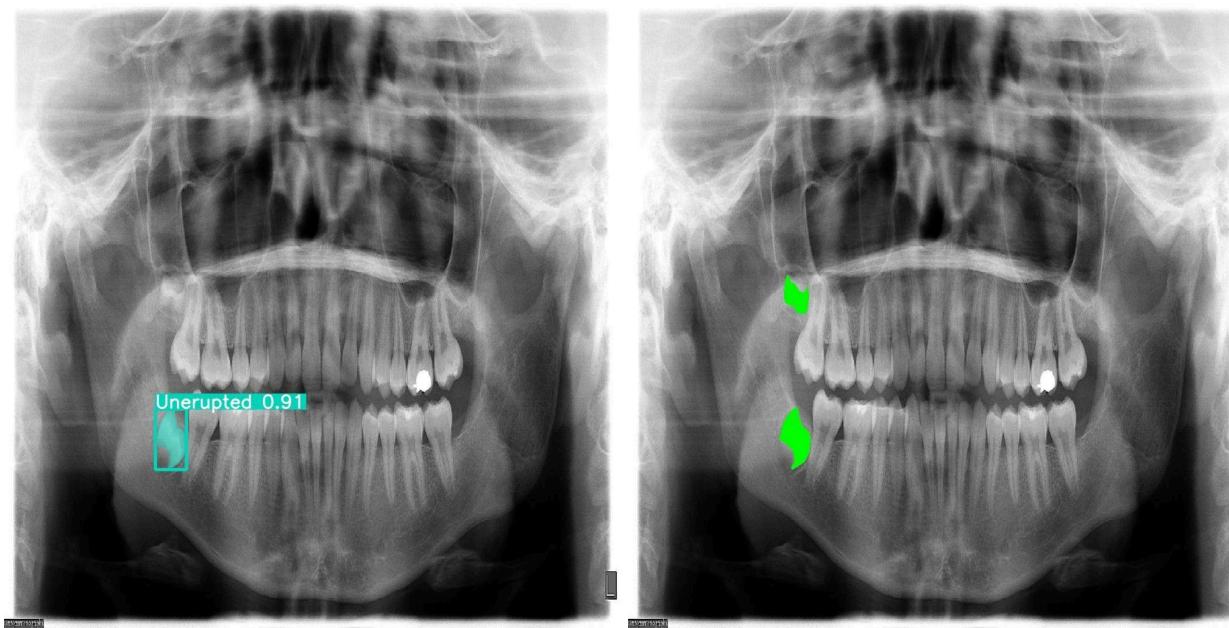
While the model is able to predict splinted crowns and with good confidence, there are major issues. As can be seen below

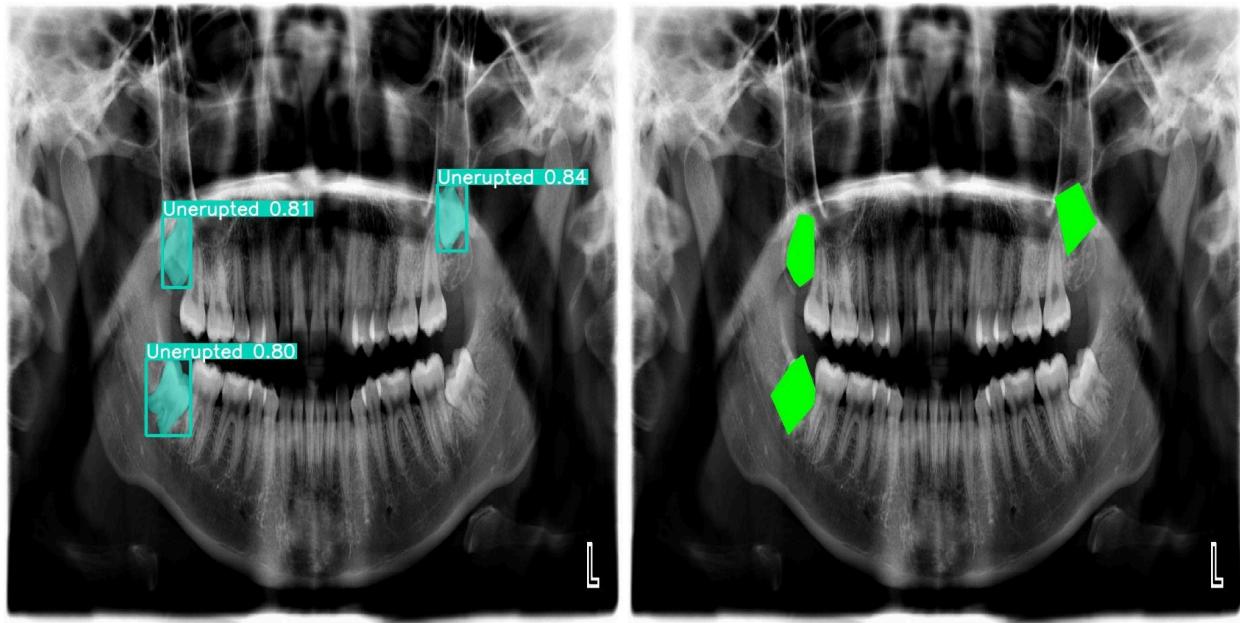


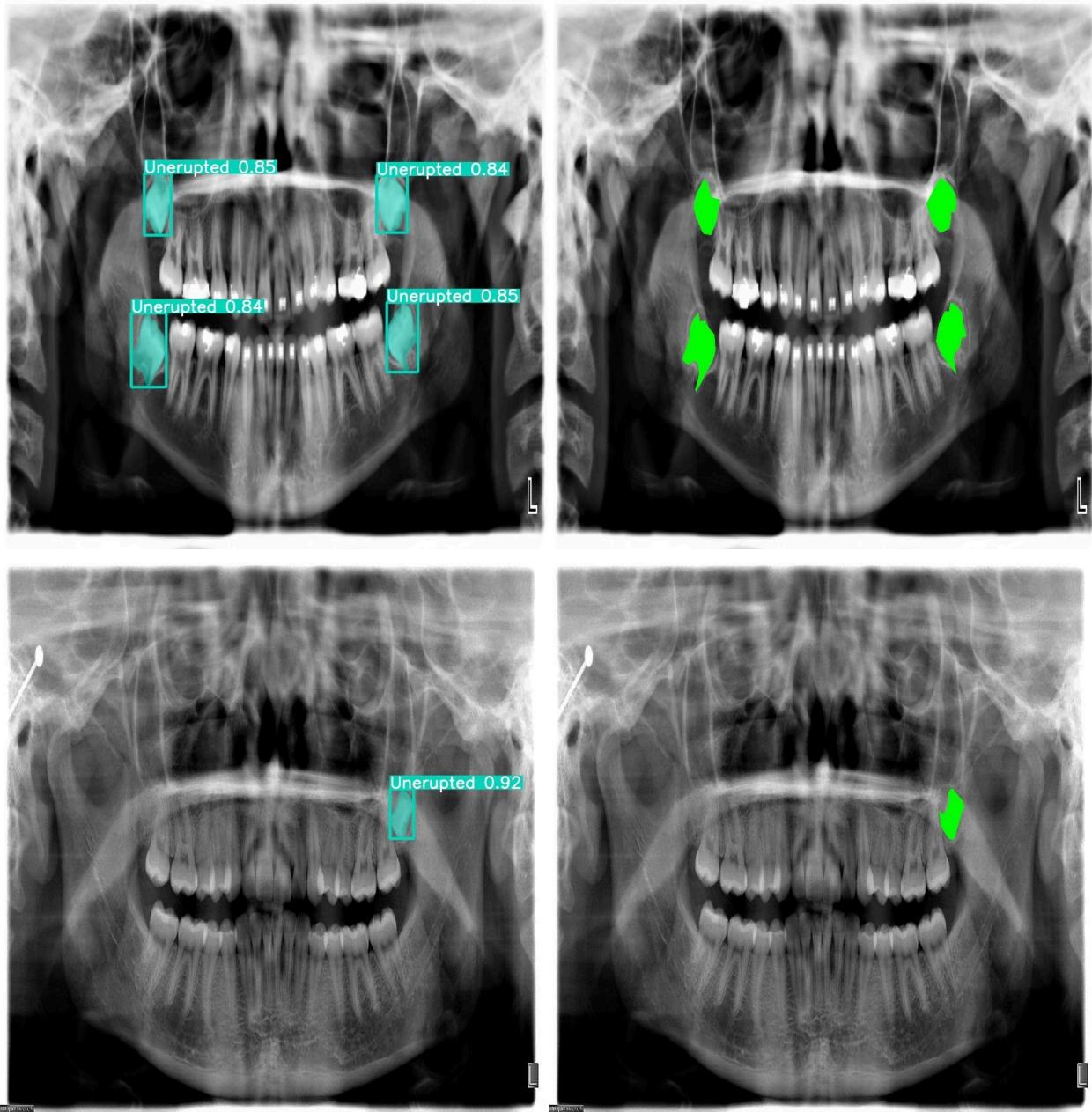


The problem with splinted crowns is that firstly, it is the least abundant of all the classes comprising 0.75% in total, it also looks very similar to two other classes, namely the bridge class, and the crown class, both of which dwarf the class in sheer numbers 1.56% (basically double) and 9.56% (more than 10 times the number). The way to improve output would be to have data which has more splinted crowns.

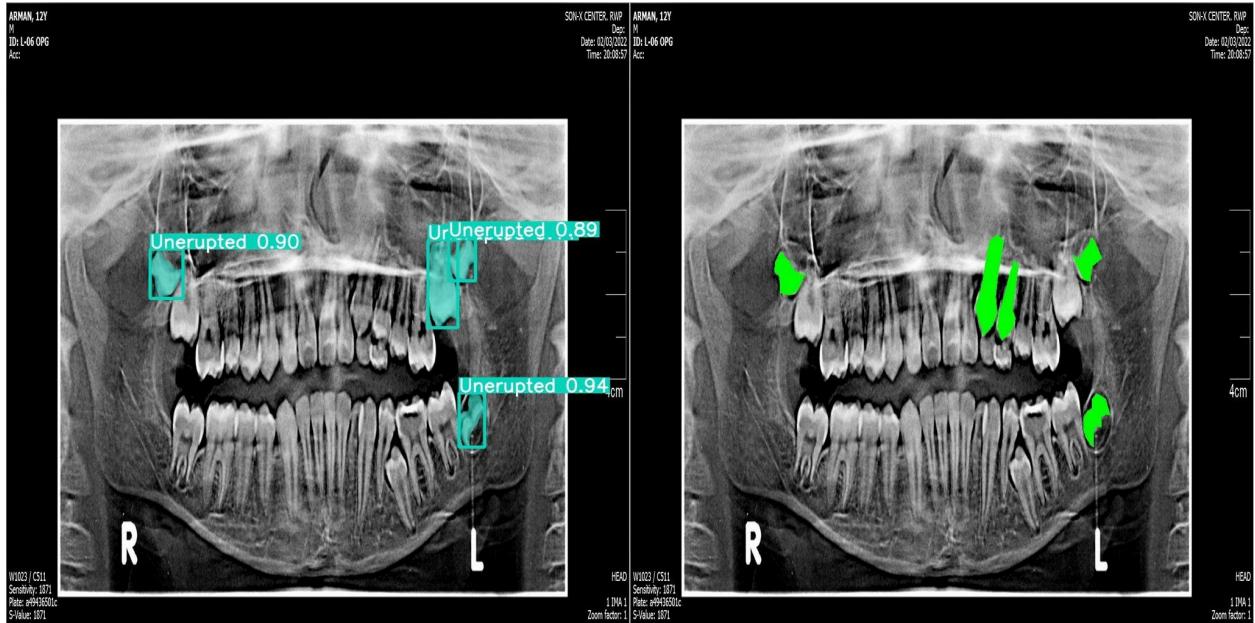
Unerupted
Test data



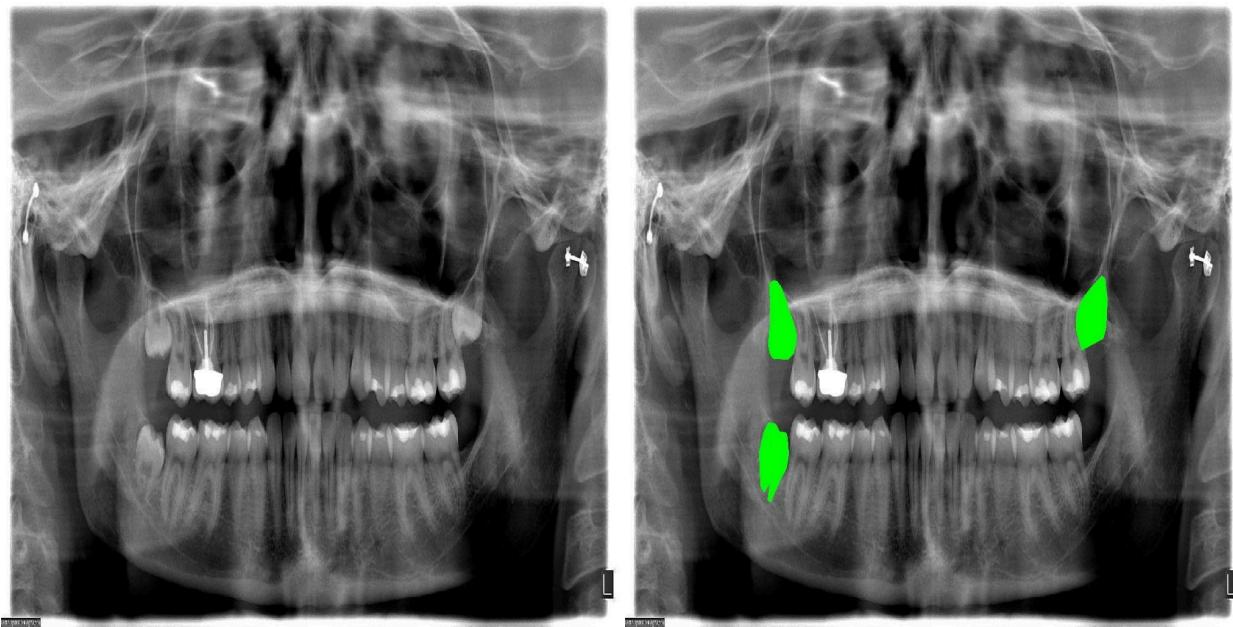




While we see that the model is able to predict unerupted, it does run into issues as seen here



And here



The model is unable to recognize unerupted teeth in the above two images, because it is trained to believe that small teeth on the corners can be unerupted and not the larger ones or those, that are located more centrally. This can only be due to lack of that type of unerupted data in the training dataset. Unerupted is the second least present class in the dataset.

Suggested Improvements

To improve the model, we will have to go towards a tooth centric approach to solve the small object problem. What else we can do, to solve the dark object dark background problem we can do preprocessing. An example of preprocessing is Histogram equalization, what this can do is

improve the outline of the tooth with respect to the background, which would make it easier to detect caries.

Below is an example of an image and then itself but equalized



(base image)



Equalized