CBCT analysis in osteoradionecrosis case followed by hyperbaric oxygen treatment (a case study)

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ABSTRACT
Osteoradionecrosis is an infectious disease and inflammation that occurs in the jaw after doing radio therapy. Radiographic picture of the disease is visible lesions lucent extensive radio in the jaw. In Clinical condition, seen fistula and abscess in the jaw. One therapy for the treatment of this condition is the Hyperbaric Oxygen. The purpose of this paper is to look casereport work hyperbaric oxygen therapy in treating osteoradionecrosis. Patient age55-year-old, woman, came with complaints of pain in left and right lower jaw, since one month ago, after doing radiotherapy for 6 months. Patients diagnosed osteoradionecrosis. for the healing, selected medical therapy and patients are advised for doing oxygen hyperbaric therapy in AL Minto Harjo hospital Jakarta. One month after doing hyperbaric oxygen therapies seen change and healing. Lesions that form still has the same broad but disappeared fistula, abscess dries, necrotic tissue disappeared / reduced as well as the formation of new bone matrix. As conclusion, , obviously able to heal lesions caused osteomielitys oxygen therapy hyperbaric osteoradionecrosis.

Keywords: Cone Beam Computed Tomography, oxygen therapy hyperbaric.

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INTRODUCTION
Osteoradionecrosis (ORN) is the term of tissue categorized by the occurring necrosis tissue after performing radiotherapy. It is the complication mostly frightened in radiotherapy measure in the neck and head cancer cases. In reality, ORN can occur only when the radiation therapy is performed with dose of radiation ranges from 50-60 gray, whereas the tissues usually will turn out to be death spontaneously in above 60 gray. The prevalence which reveals about the ORN occurance from 1970 until now only revolves 5.4-11.8%.

In the histological aspect, ORN consists of lenient tissue and necrotic bone. The occurrence is started after radiation therapy. The tissues undergo hypoxia caused by damaging the capillary blood vessel in normal tissues, and then generally ruins the vascularization in the tissues. This term causes death in the collagen cells and culminates into cell death. The body
actually responds this term by forming the new cells, however, the lack amount of oxygen occurs because of the diminished vascularization in the areas so that the process of cell necrosis is faster than the formation of new cells. ORN clinically will appear as an unrecovered wound. ORN in each of individual does not occur, it depends on the individual reaction against radiation. ORN more often occurs on mandible because it naturally have minimal vascularization and higher dose than maxilla. 1, 4, 5

The imaging process is highly necessary for the analysis requirement in ORN case therefore some instruments are required to describe it well. Ones greatly are administered such as panoramic, CBCT, and CT whereas the more appropriate modality is CT, but unfortunately, to settle this equipment requires a lot of expenses. CBCT is the instrument which is the most likely to analyze the well-detailed depiction because of its three dimensions. 6–10

CASE REPORT

A 55-year-old woman comes to Tooth and Mouth Sekeloa Hospital in Bandung complaining the swelling and pain in all part of her mandible. This complaint had occurred for six months after performing the radiotherapy for nasopharing tumor case. Generally the patient is in a limp and painful condition. The extra-oral examination showed the extensive swelling in the mandible resulting a change of her face shape, lenient consistency, and when pressed, the patient felt pain, warm, and reddish. The intra-oral examination showed the swelling on all mandible regions both left and right anterior and posterior. To complete the diagnosis, panoramic examination and radiograph CBCT were conducted and the result showed that there are lessions: a. Locations: left and right mandible from the first premolar region until the third molar, b. Margin: unlimited/irregular, c. Internal structure: radiolucent, multiple d. the effect against around tissue: the bone around the lesion area appears vanished/resorption.
Figure 1. In the radiograph panoramic’s patient were found radiolucent lesions in mandible from the left and right regiopremolar to the mandible corpus, followed by multiple and unlimited lesion and cortical bone of left mandible which is disconnected.  

At the time, the patient was treated with antibiotics, analgesic, and roburatia. The patient is suggested running the Hyperbaric treatment in AL Mintohardjio Hospital, Jakarta. Three months after the treatment, the patient returned to conduct CBCT and evidently, there was significant improvement. The interpretation revealed:

Table 1. The examination results of patient before and after hyperbaic oxygen treatment.

<table>
<thead>
<tr>
<th>Before Treatment</th>
<th>After Treatment</th>
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<tbody>
<tr>
<td><strong>The Examination on left mandible</strong></td>
<td><strong>CT imaging</strong> :</td>
</tr>
<tr>
<td>CT imaging: Extensive lesion in the mandible cortical bone is disconnected.</td>
<td>Improvement from initial radiograph which forms bone on lesion area.</td>
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<td></td>
<td>Although the cortical bone was not close yet, it appears like the process of healing step.</td>
</tr>
<tr>
<td>Axial: There was lesion on axial and it has 26.8</td>
<td>Axial: There was extensive lesion in that the</td>
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mm long and 8.2 mm wide which was observed as the largest. The process of healing or the bone lesion was not formed yet.

<table>
<thead>
<tr>
<th>Sagital</th>
<th>Sagital:</th>
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<tbody>
<tr>
<td>There was extensive radiolucent lesion on mandible corpus with the limit of ill define and left mandible of cortical bone was disconnected. It has 6.9 mm in length and 20.3 mm in height of influenced corpus.</td>
<td>The mandible cortical bone became thick and grew in various spots which categorize that healing process occurred.</td>
</tr>
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### The Examination on Right Mandible

<table>
<thead>
<tr>
<th>CT Imaging:</th>
<th>CT Imaging:</th>
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<tr>
<td>In the bone surface, we could observe that circumstance is still intact without abnormality, the bone damage does not reach the anterior mandible, but only there is bone damage in linggir of left anterior mandible. We can observe that the bone thickness from anterior to posterior looks diminished so that the mandible looks thinner. We can estimate that the bone run into resorpsi from bucal line.</td>
<td>After conducting the Hyperbaric treatment, evidently, the anterior mandible does not appear significant improvement, but bone compression quantity has shown the increase.</td>
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<tr>
<th>Axial:</th>
<th>Axial:</th>
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<tr>
<td>The range of thickness in front linggir was 4.2 mm long so far from normal circumstance +/- 8-9 mm long</td>
<td>We can observe that the thickness of left anterior linggir increased from 4.2 mm to 5.3 mm long. It proves that significant bone growth has occurred in buccolingual line.</td>
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<tr>
<th>Sagital:</th>
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<tbody>
<tr>
<td>Beginning: in sagital section, we can observe that the quality of right mandible is more defective than that of left mandible. Trabekula from bone tissue emerges diminished and irregular. The</td>
<td>The mandible was improved, with neat pla trabekula and the density value increases from 150-170 Hu to 250-300 Hu. It proves that the improvement also occurred in bone quality</td>
</tr>
</tbody>
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average of bone density is 150-170 HU

**Right Mandible**

CT Imaging:
There was bone damage, mainly in lingual right mandible. In the surface of mandible bucal, the damage occurred so that the bone continuity is vanished in several areas. The bone damage from lingual looks extremely wide but the bone continuity of mandible was still integrated.

CT Imaging:
The bone circumstances, both before and after treatment, did not show significant improvement. In buccal, lesion and disconnected bone continuity still appeared in several areas. From lingual side, there was quite wide bone damage from bucal, lingual and reached almost all of mandible corpus. There is no significant improvement yet.

Axial:
The thickness of front linggir ranged 4.2 mm so far from normal circumstance +/- 8-9 mm

Axial:
The thickness in the linggir left anterior increased from 4.2 mm to 5.3 mm long. It proves that significant bone growth has been occurred in buccolingual line.

Sagital:
In sagital section, we could observe that the quality of right mandible was more defective than that of left mandible. Trabekula from bone tissue appeared diminished and irregular. The average of bone density was 150-170 HU

Sagital View:
Mandible was improved, with neat pla trabekula and the density value increased from 150-170 Hu to 250-300 Hu. It proves that the improvement also occurred in bone quality.

**DISCUSSIONS**

Osteoradionecrosis or ORN is bone necrosis affected by radiotherapy.\textsuperscript{12,13} The abnormality can be illustrated as 3H effect principles from radiotherapy; hypocellular, hypovascular dan hypoxia. This circumstance makes growth of connective tissue and other cells become hampered.\textsuperscript{13} Histologically, a bone called “necrosis” when the osteocyte which normally exists is disappear. Necrotic tissue in mouth cavity is quite susceptible against infection, pathological fracture and
secondary infection, these three matters can provoke inflammation in the tissue, so that it can cause infection. Usually, ORN is started after minimum 3 months of treatment term.\textsuperscript{7-8} In this case we can observe that in this case, the patient is diagnosed suffering ORN after 6 months run for therapy. We can assume that it is related to the patient’s condition who is quite weak and it bring through occurring secondary infection after nasopharing tumor. Besides that, from the CBCT results, we can assume that had occurred in secondary fracture of left mandible. In this case, ORN occurs in mandible and it proves that mandible is the most susceptible part of jowl. This matter occurs because of the quite supporting circumstance of bone structure.\textsuperscript{9-10}

Figure 2. a. The illustration of patient CT before conducting the treatment, b. Left mandible, pathologic fracture, c. exists mandible anterior showing no lession, but the bone becomes quite slight, d. Right mandible showing lesion and bone damage of lingual.\textsuperscript{11}
The clinical manifestations of ORN are pain, multiple fistula in suffered necrotic bone areas, fracture pathology, and suppuration. Contributing factors against the ORN growth are: tooth trauma, tumor location, radiation dose, vascularization and fractionation, the interval of radiation process, nutrient, liquor, and the use of tobacco, as well as chemotherapy. In this case, ORN probably occurs as consequence of patient’s condition which is not very well. The patient is too hard to eat and drink after nasopharing surgery, it makes the patient turn out to be weak and susceptible against infection.

Clinically, there are three types of ORN such as: 1) Type I: ORN caused by trauma after surgery, 2) Type II: ORN caused by trauma for 1 year or more during the radiation therapy, and the last 3) Type III: this type is also known as spontaneous type in that ORN can occur anytime, but on the average occurs after conducting the radiotherapy for 6 months until 2 years. In this case, the secondary infection and pathologic fracture occur therefore it is probably ORN type III which occurs spontaneously however, the incident is earlier than the initial research’s suggestion (6 months - 2 years after surgery). It can probably come about the prevalent circumstance and poor nutrient of the patient.

During several years, ORN has been treated by various means, evidently the results are not ideal and successful yet. Hyperbaric oxygen serves as reference therapy, although it is still considered as controversial one by several specialists because the results of the therapy are still dubious. Some research clarifies that HBO provides fascinating result toward prophylactic before tooth extraction of the patient which is considered being the risk of developing ORN.

Hyperbaric Oxygen Treatment (HBOT) is the treatment which administers highly pressurized oxygen moreover than atmosphere pressure provided to tissue to escalate the recovery process, chiefly in lesion followed fewer blood vessels. It requires the utilizations such as pressurized room and sender tool of 100% oxygen. Initially, HBO is administered in the treatment of decompression disease, it has quite great efectiveness in medicating gaseous gangrene and carbon-monoxide virulence. HBO is treatment modality
which administers high oxygen pressure. The technique puts the patient on pressurized room (monoplace or chamber). The patient is put in the room for 1 hour to be provided with pure oxygen. There are three criteria where the treatment is called “successful”: there is no effect in the bone, shows fistula closing (if there is) and does not show indication in other tissues. It is successful when completing minimal two criteria.

In this case, the prevalent circumstance of the first patient arrival was not in a good condition that she was hardly capable to eat and has soreness that is unable her to walk and came by wheelchair. There was multiple fisula in intraoral. After running the HBO treatment for three months in Mintoharjo Hospital in Jakarta, the patient showed a quite significant improvement. Generally, prevalent circumstance turns out to be very well and the patient can eat and drink without obstacle and soreness, and she can walk and speak very well. After the treatment, the fistel turns close and generally, there is no effect in her body and bone. If we refer to the stipulation, we can assume that the HBO treatment is successful.
**Figure 3.** The CBCT image of the patient (pre and post HBO treatment). **a.** In left mandible (pre HBO) shows pathological fracture followed necrotic lesion in several parts of the lesion. **b.** In left mandible (post HBO) the fracture is stills showed but the necrotic tissue in the inside part of the lesion has been vanished. **c.** The bone thickness of anterior mandible (pre HBO) turns out to be quite slight. **d.** The bone thickness of anterior mandible (post HBO) become escalated.  

When the tissue encounters radiation, the recovery process runs normally, where the center of lesion will be surrounded by tissues which have normal perfusion so that the process of body biochemistry turns out to be precursor for occuring the initial inflammation process and finally the fibrous tissue is formed. However, this process does not run well because of the circumstance after providing radiation in that lactic acid level, iron, and oxygen diminish so that the stimulation to conduct the recovery process is difficult to form and it is added with the minimum vascularization circumstance, therefore automatically the recovery process also diminishes. In this case, the patient runs radiation and it is shown by radiograph that there is tissue death proven by the appearance of spot radiolucent image inside the lesion.

**Figure 4.** Radiolucent spot reveals that there is partial of the tissue that becomes necrotic in right and left mandible after conducting the radiotherapy, before conducting the HBO treatment.  

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After conducting the HBO treatment, evidently, the radiolucent spot is vanished and changes into intermediate image of the tissue. It reveals that there is a new tissue formation process. Besides that, clinically, multifistel which existed before treatment was also disappear. From the figure, we can see there is a significant switch and after conducting the treatment only for three months forms a new tissue as well as it proves that the HBO treatment is the suitable therapy for this case.

**Figure 5.** There is a radiolucent spot which tends to disappear after conducting the HBO treatment.\textsuperscript{11}

The recovery process administered by HBO treatment is by means of escalating the oxygen pressure which is available in all tissues and diminishes embolism and gaseous volume in the body. The effect of the escalating oxygen pressure is the increase of oxygen transportation capacity from blood. In normal atmosphere pressure, oxygen transportation is restricted by the oxygen capability to bind hemoglobin in red blood cells. With HBO, stimulant to escalate oxygen transportation also increases. New evidence clarifies that HBO can mobilize the parent cell/progenitor from bone marrow through the nitric oxide mechanism so that the tissue regeneration process become faster.\textsuperscript{31}

Hyperbaric Oxygen escalates the amount of free radical oxygen and can oxidize protein and lipid of membrane, damage DNA, and obstruct the function of bacterium metabolism. HBO is quite effective against anaerob bacteria and supports peroxide system of leukocytes in eliminating the bacteria. Lesion recovery normally occurs through hemostasis step, infection agent eradication, inflammation respond
resolution, reformation of matrix connective tissue, angiogenesis, and resurfacing. Chronic injury does not fully continue these processes because of least factors of local and systemic host. Failed injury in recovery process is usually hypoxia. Several components of injury recovery process are also influenced by oxygen concentration. It reveals why HBO is the fine therapy for chronic injury.

The most existing mechanism is that increased osteoclasts occurs by using HBO. Necrotic bone resorption by osteoclast depends on oxygen. Invivo research has proven that it become better in animals suffering ORN. Besides that, as mentioned before, HBO treatment can facilitate penetration or antibiotics function. Other HBOT characteristics as clarified before are like neovascularization and obstructive inflammation respond and other possible treatment benefit.

Cone-beam computed tomography (CBCT) is imaging technique which produces three dimension image which has high resolution and low dose when compared to the conventional CT. CBCT exploits cone ray emission and rotating detector by capturing two dimension image and reconstructing it into three dimension image. CBCT also provides image with small view so that the images are able to administer for endodontic diagnosis requirement and monitor before and after treatment. At this time, many researchers learn CBCT ability in more science dentistry to observe CBCT clinical application in dentistry therapy.

In dentistry, CBCT turn out to be treatment standard where it is quite necessary. Taking picture in CBCT is conducted by applying gantry which rotates to the source of X-ray and detector following suitable gantry movement which focuses in focused line also known as ROI. During radiation, there are hundreds of planar images obtained in suitable field of view (FOV), minimum of 180° in bow. CBCT software will fuse all of recorded images. All FOVs are only sufficient in one times of rotation to reconstruct image. CBCT is complement modality to apply particularly and does not serve as substitute for 2D modality image. The width of FOV or scanned volume depends on the detector’s size and form, geometrical, and collimate ability. The FOV form is able cylinder or circle like in Newton 3G.
CONCLUSION

CBCT is a quite accurate radiograph modality in evaluating the abnormality of tooth and jowl including the osteoradionecrosis therapy by using Hyperbaric Oxygen.

REFERENCE

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