A Radiographical Study on Skeletal Deformities in Cultured Rainbow Trout (*Oncorhynchus mykiss*) in Iran

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**Abstract:** Skeletal deformities in farmed rainbow trout (*Oncorhynchus mykiss*) are often observed in intensive farming systems and result in production losses. This study was done to detect different forms of skeletal deformities in rainbow trout collected from fish farms in 2008 and 2009. Deformities were diagnosed by clinical observation, radiographic and histopathological evaluations. Various patterns of skeletal deformities were observed in studied fish including Lordosis, kyphosis, Scoliosis, fusion of vertebrae, mandibular joint deformity, two mouth fish and parrot-like head. Relative incidence of vertebral fusion, lordosis, kyphosis and scoliosis were 35, 31.6, 20.8 and 12.5%, respectively. The reasons for the observed deformities could not be definitively determined, but possible etiologies were discussed.

**Key words:** Fish deformity • Rainbow trout • Radiography

**INTRODUCTION**

With development of intensive fish farming, an increased occurrence of skeletal deformities in rainbow trout (*Oncorhynchus mykiss*) has been observed in Iran during the last decade. Skeletal deformities in fish may be caused by pollutants and chemicals, nutritional deficiencies, Infectious diseases and genetics. Moreover, some environmental factors such as thermal shock and overcrowding might play a role in the generation of deformities in fish during early growth stages [1, 2]. Deformity mechanisms are not yet well understood [3] but in most cases appear to be linked to the disruption of early developmental processes [4]. Although numerous clinical reports have discussed the possible causes of skeletal deformities, none have definitively documented a specific cause. Most of the reported deformities have been attributed to the following causes: vitamin C deficiency, exposure to heavy metals, high levels of vitamin A, organophosphate and organochlorine chemicals, inbreeding, traumatic injury [5]; strong water currents in very early developmental stages [6]; the histozoic parasite, *Myxobolus cerebralis*, *Icthyophonus hoferi* infection [7, 8] and bacterial and viral infections [5, 9, 10]. Various types of deformities have been reported in different fish species including scoliosis, lordosis, mandibular and operculum deformities, pug-head, stump body, double fins and fin fusion [3, 11]. In the past, most diagnoses of fish diseases were made through euthanasia and necropsy because clinical or physical evaluations of fish and available diagnostic tests were limited [12]. Today, diagnostic imaging is used as a complementary technique to further evaluate specimens. This study reports different skeletal deformities in cultured rainbow trout in Chahrmahal va Bakhtyari Province which is a major trout production area in Iran with annual production of 13000 tones.

**MATERIALS AND METHODS**

**Fish Samples:** A total of 120 fish specimens (12.5±1.3 cm length) were randomly collected from 10 fish farms. Clinical examination of fishes was performed at the fish farm harvesting area. Fish were killed by anesthesia in 25 ppm Benzocaine. Gross skeletal deformities were determined by examination of the external morphology of freshly euthanized. Deformed and comparably normal fishes were transferred in cool boxes to the Fisheries Research Center, IAU, Shahrekord branch for further evaluation.
Radiographic Examination: A portable X-ray apparatus (Toshiba-Varian, TF-6TL6, Utah, USA) with a technique chart utilizing 40-50 kV and 10-20 mA was used. For radiographic imaging, fishes were placed on 30*40 cm films (AGFA) in lateral and/or dorso-ventral positions. The number of vertebrae in rainbow trout varies between 54 and 63, therefore, the vertebral column was divided into a cranial part from vertebrae no. 1 to 20, a medial from vertebrae no. 21 to 40 and a caudal from vertebrae no. 41 to the caudal fin. The location and variation of deformities including lordosis, scoliosis, kyphosis, compressed or fused vertebrae and collapsed intervertebral spaces were examined by observing the structure, size and position of the vertebral column.

RESULTS

Various patterns of skeletal deformities were observed in examined fishes including Lordosis, kyphosis, Scoliosis, fusion of vertebrae, mandibular joint deformity, two mouth fish and parrot-like head. Relative incidence of vertebral fusion, lordosis and scoliosis was 35, 31.6, 20.8 and 12.5%, respectively. The predominant types of spinal deformities observed were fusion and lordosis (Figure 1) and cranial deformities including deformities in head, jaws and operculum were less observed. The most prevalent abnormalities of the spinal column were fusion and lordosis and many fish had spinal columns showing curvatures up to 45°. Lordosis is characterized by the formation of a V-shaped curvature of the spinal column (Figure 2).

Skeletal deformities were observed in the cranial, medial and caudal region of the spinal column. However, the most frequently affected vertebrae were generally in the medial part of the spinal column (Table 1).

DISCUSSION

Skeletal deformities in rainbow trout farmed by the Iranian aquaculture industry constitute an economic problem that decreases the market value of fish. Such deformities are rarely observed in natural fish populations but are quite common in farm-raised [12]. Several studies have focused on deformities of the skeletal system and vertebral column of fish in different countries [3, 11, 12] but skeletal disorders of farmed rainbow trout are less studied in Iran.

The economic consequences of vertebral deformities are significant in terms of reduced weight and more importantly, due to a much reduced value per kg fish slaughtered. The heritability of the deformity is substantial. Thus, selection against vertebral deformities is an option. However, selection intensity should, in principle, be saved for traits that cannot be improved by means of better environmental management. Therefore, further efforts should be made to explore the various aetiological causes of the deformities before further critical choices are made.

In this study various patterns of skeletal deformities were observed in examined fish including Lordosis, kyphosis, Scoliosis, fusion of vertebrae, mandibular joint deformity, two mouth fish and parrot-like head. Relative incidence of vertebral fusion, lordosis and scoliosis were 35.5, 31.8 and 11.8%, respectively. Although, the exact cause or causes of the vertebral deformities in the present study remains unexplained but a wide spectrum of aetiologies have been suggested for skeletal deformities, including genetics, inbreeding depression, temperature fluctuation during early life stages, low water pH, parasitic infection, nutritional deficiencies and environmental pollution [12]. Gjedrem et al. [13] indicated that genetic source of fish has an important role in skeletal deformities. Intensive inbreeding might also lead to a high incidence of spontaneous skeletal deformities such as scoliosis, lordosis, curved neural spines, fused vertebrae and compressed vertebrae [13]. Inbreeding also leads to a high incidence of spontaneous skeletal deformities such as scoliosis, lordosis, curved neural spines, fused vertebrae and compressed vertebrae. Traumatic injury, especially during sorting operation, could be another possible cause of skeletal deformities in fish. The muscles of fish are assorted in bands called somites. These somites may be damaged or die if subjected to strong water currents or a bird attack, which can lead to spinal curvature. Nutritional factors, such as vitamins C and D, calcium and
Table 1: Different forms of skeletal deformity in cranial, medial and caudal parts of vertebral column

<table>
<thead>
<tr>
<th>Vertebral column</th>
<th>Fusion (%)</th>
<th>Lordosis (%)</th>
<th>Kyphosis (%)</th>
<th>Scoliosis (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial part</td>
<td>4.1</td>
<td>2.5</td>
<td>6.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Medial part</td>
<td>13.3</td>
<td>19.1</td>
<td>11.6</td>
<td>7.5</td>
</tr>
<tr>
<td>Caudal part</td>
<td>17.5</td>
<td>10.0</td>
<td>2.5</td>
<td>4.1</td>
</tr>
<tr>
<td>Total</td>
<td>35.0</td>
<td>31.6</td>
<td>20.8</td>
<td>12.5</td>
</tr>
</tbody>
</table>

phosphorus, are likely to impact on deformity rates and as such may explain the occurrence of deformity later in developmental stages of fish. Vitamin C deficiencies might lead to spinal malformations including kyphosis, scoliosis and lordosis [14]. Several individual cases of spinal deformities in catfish were attributed to vitamin C deficiencies. This deficiency could be due to either an inability to synthesize vitamin C or to vitamin C production that is insufficient for normal cartilage, bone and connective tissue formation [14, 15]. Moreover, fish exposed to agricultural drainage water containing pesticides might be susceptible to decreases in the physiological functioning of vitamin C. Consequently, these chemical exposures might affect skeletal collagen, resulting in spinal deformations [14].

To prevent skeletal deformities and economical consequences, it is recommended not to select the breeders from families with high incidence of deformed fish and, of course, not at all the breeders showing the deformity themselves. Improvements of management and also nutritional and environmental conditions have a critical role in decreasing skeletal deformities. Such a procedure will reduce the deformities significantly and prevent a further increase in the incidence of vertebral deformities in the population.

REFERENCES
