

MEDICAL CHECK-UPS FOR DYSBARIC OSTEONECROSIS AND TREATMENT

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Introduction

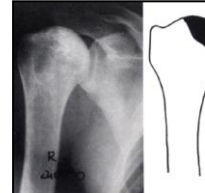
Dysbaric Osteonecrosis(DON) is one of most serious problems for divers/compressed air workers. We have been doing medical check-ups specializing in DON for them who request it since 1981. We have done them in 272 divers and the total number was 531 between 1981 and 2014.

Diagnosis of DON

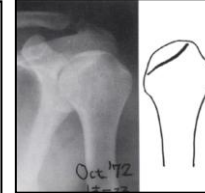
The diagnosis of DON is mainly judged by X-rays and MRIs. We take X-rays of the shoulders, hip joints and knees where there are high incidences of DON, additionally we take them of the elbows, if they tell us they are having any symptom in their elbows. We use the Ohta-Matsunaga criteria. It categorizes DON as type A (juxta-articulars lesion) and type B (head, neck and shaft lesion). Moreover, type A is classified from A1 to A6, and type B is classed from B1 to B3. (Fig.1) MRI is effective to know the range of DON.

Type A: Juxta-articular lesions

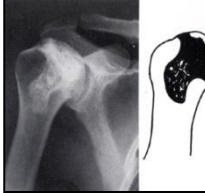
Intact articular cortex



A1
Segmental opacities

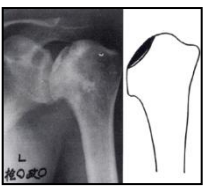


A2
Linear opacity




A3
Mass opacities

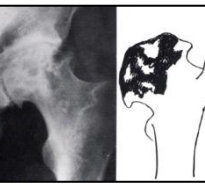
Structural failure



A4
Sequestration of the cortex

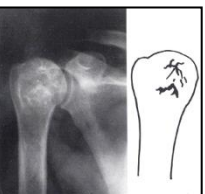


A5
Collapse of the cortex




A6
Osteoarthritis

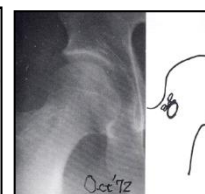
Type B: Head, neck and shaft lesions



B1
Dense areas



B2
Irregular calcified areas



B3
Transradiant areas and cysts

Outline of examinees (1981 – 2014)			
The number of examinee		272	
Male		268	
Female		4	
Cumulative total number of examinee		531	
Mean age		37.5 ± 11.3(years)	
Mean duration of works		11.9 ± 10.8(years)	
Exposure to high pressure by			
Diving		203	(74.6%)
Compressed air work		69	(25.4%)
Occupation			
Fisheries		111	(40.8%)
Engineering works		87	(32.0%)
Research		31	(11.4%)
Salvage		12	(4.4%)
Machine maintenance		4	(1.5%)
Unknown		27	(9.9%)

In Japan, it is provided by law that workers who are exposed to high pressure have to take a medical check-up special for workers in high pressure annually. The number of examinee was 272, 112 of them came repeatedly, the cumulative total number was 531. Three quarters were professional divers and the others were engineering workers in compressed air such as caisson.

Result

Detection rate of DON:
80/272(29.4%)

The proportion of DON: type & site

Shoulders(24.1%)
A1: 26(19.0%)
A2: 6 (4.4%)
A5: 1 (0.7%)

Hip joints(6.6%)
A1: 3 (2.2%)
A2: 5 (3.6%)
A3: 1 (0.7%)

Tibia(14.6%)
B1: 1 (0.7%)
B2: 19 (13.9%)

Type A: 42(30.7%)
Type B: 95(69.3%)

Humerus & Radius(16.1%)
B1: 11(8.0%)
B2: 6(4.4%)
B3: 5(3.6%)

Femur(38.7%)
B1: 5 (3.6%)
B2: 23(16.8%)
B3: 25(18.2%)

A1: 21.1%
A2: 8.0%
A3&A5: 0.7%

B1: 0.7%
B2: 12.4%
B3: 21.9%

DON incidence according to occupation

Occupation	DON (+)	DON (-)	Examinee
Fisheries	48 (43.2%)	63	111 (40.6%)
Compressed air worker	21 (24.1%)	66	87 (32.1%)
Researcher under water	4 (12.9%)	27	31 (11.4%)
Salvage	3 (25.0%)	9	12 (4.4%)
Machine maintenance	(0.0%)	4	4 (1.5%)
Unknown	4 (14.8%)	23	27 (10.0%)
	80	192	272

DON incidence according to the occupation is highest in fish divers(43.2%).

Comparison DON(+) V.S. DON(-)

		DON(+)		DON(-)		P value
		n	Mean±SD	n	Mean±SD	
Age	(years old)	80	40.1±10.3	192	36.4±11.69	*0.013
Duration of work	(years)	71	14.8±10.5	167	10.7±10.7	**0.006
Frequency of work	(days per year)	16	145.6±91.6	37	174.1±82.1	0.271
Average depth	(m)	63	17.9±6.5	147	18.0±8.8	0.900
Maximum depth	(m)	75	43.5±48.3	168	41.2±37.4	0.718
Blood examination						
Total cholesterol	(mg/dl)	70	194.3±36.1	140	193.7±33.4	0.907
Neutral fat	(mg/dl)	75	210.5±185.0	143	152.3±118.8	*0.015
Uric acid	(mg/dl)	69	5.7±1.4	104	5.8±1.1	0.676
Blood sugar	(mg/dl)	73	98.6±34.1	115	91.0±26.4	0.107
platelet	(x10 ⁴ /mm ³)	62	25.6±5.6	114	25.4±5.1	0.953

We compared DON(+) group with DON(-)group about some factors which are expected bring about DON with the t-test. The work duration and examinee’s age were longer, and neutral fat level was higher among DON(+) group than DON(-) significantly.

	DON (+)	DON (—)	P-value
Occurrence of bends in past			
(+)	29	47	*P<0.0258 (chi-square test)
(—)	51	145	
Decompression management			
(+)	14	66	**P<0.0001 (chi-square test)
(—)	39	36	

We focused the relationship between DON and bends and decompression management. Above cross tabulation shows: whether examinees had bends in past , whether examinees keep proper decompression procedure such as using decompression tables, using diving computers. Each relations were tested by the chi-square-test. The both

	DON (+)	DON (-)		
1972-1980 (Kawashima et.al.)	421 (56.4%)	326 (43.6%)	747	**P<0.0001 (chi-square test)
1981-2014 (This study)	80 (29.4%)	192 (70.6%)	272	

SCUBA diving

Helmet diving

Typical diving in certain fishermen’s villages.

Consideration

Characteristics of examinees whom we performed medical check-ups were many fish divers dive recklessly. In a certain fishermen village, they dive into from 10 to 40m depth by helmet for 8 hours in a day for catching shells. When they ascent, they don’t observe a regular ascent procedure, they do their original procedure. In another fishermen village, they repeat diving such as 5-8 times in a day. Such reckless diving method was seen particular in 30 – 20 years ago.

About the decompression management, almost of salvage company and construction/engineering companies use decompression tables as follows: the Japan governmental table, the U.S. Navy’s table. Company employed worker such as engineering works were administrated properly.

Surgical treatment of DON

Twenty-two DON cases in 21 patients were had surgical treatment. One diver of them was taken on the both femur heads. Mean age of surgical cases was 38.8±10.7 years old, youngest was 24 years old, and oldest was 66 years old. Sixteen cases were making good progress after operations, but 6 cases of them required re-operation. One case which was taken a synovectomy was carried out a TSA for a re-operation 3 years 1 month later from the first operation. Four cases which were taken rotation osteotomy were carried out a replacement arthroplasty in: 5 years 6month, 2 years 5 month, 2 years 10 month, and 3 month later from the first operation. One case which was taken a THA was required a THA operation again 2 years 5 month later.

Surgical procedure	• Hip joint • Femur head		• Shoulder • Humerus head	
	Initial operation	Re-operation	Initial operation	Re-operation
Varus osteotomy	5		0	
Rotation osteotomy	13	⇒(4 cases)THA	0	
Replacement arthroplasty			0	
	Conventional THA	0		
	Re-surfacing THA	2	⇒(1 case) Conventional THA	
Synovectomy	0		2	⇒(1 case)TSA
	20	5	2	1

As for their life after having had an operation, there is the person needing a stick among them, but most people can live a normal life, and there is the person who returned to hard labor including diving work and the work at an unstable place such as the operation of the boat among them.

Varus osteotomy

By cutting off a part of below femur bone head in wedge and fix with a metal plate, femur bone head is changed angle and shifted a loaded part or extended the contact part.

Rotation osteotomy

By rotation of bone head, the bone lesion can shift from loads. Moreover, by slanting bone head at the same time, the proportion of normal part which contact to a joint increases.

THA(Total Hip Arthroplasty)

↑ Hip resurfacing arthroplasty

Hip resurfacing arthroplasty is attracted method from 1990s. It is advantageous than standard THA in follows points: they can remain own bone, therefore it is less invasive, less occurrence of dislocation. Also, it may be had re-operations easily in future. This method is suitable when femoral neck keeps form and strength, it was performed for younger patients. For new method, long-term treatment result has not been known is weak point.

↓ Conventional THA

Conclusion

- We summarized result of medical check-ups specialized DON from 1981-2014.
- We carried out it to 272 divers/compressed air workers, the total number was 531.
- DON was found in 80 out of 272, detection rate was 29.4%.
- DON tend to be found in longer work experience, it may have correlation to occurrence of bends and decompression management in their daily work.
- We performed surgical operation to 22 DON cases. Six cases among them required re-operation, all cases can be leading as same as their former life.