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Assessment of growth activity in the mandibular condyles by single-photon emission computed tomography (SPECT)

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Background: Unilateral condylar hyperplasia can lead to marked and disfiguring changes in the face and occlusion. A method of determining side-to-side differences in condylar activity is an important step in managing this condition.
Aims: To determine the growth activity in normal mandibular condyles and to devise an index of side-to-side differences in condylar activity in different individuals.
Methods: Thirty eight patients, ranging from 13 to 34 years, who were undergoing skeletal scintigraphy for a variety of conditions agreed to participate in this study. No subjects had clinical or radiographic signs of mandibular hyperplasia. After injection of 25 mci Tc^{99} the uptake by the right and left mandibular condyles was measured and the side-to-side differences used to calculate an index.
Results: The maximum side-to-side differences were 6.2 per cent (Right side versus Left side: 53.1 per cent and 46.9 per cent respectively) in the male patients and 5.7 per cent in the female patients (Right side versus Left side: 52.85 per cent and 47.15 per cent respectively).
Conclusions: The variation in growth activity in normal right and left mandibular condyles was less than 6.2 per cent.
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Introduction

Condylar hyperplasia of the mandible is a pathological state of development that can lead to facial asymmetry, lateral open bite, mandibular deviation, malocclusion and articular dysfunction.[1–4] It usually occurs between 10 and 30 years of age and frequently after the adolescent growth spurt. It rarely occurs before 10 years or after 40 years of age.[1,5,6] There is no gender preference,[7,8] although some studies have shown that it is more common in females.[9]

In this self-limiting deformity active growth may continue for many years and result in severe facial deformity.[6] The abnormality in a young patient is condylar enlargement and ramus lengthening on the affected side.[5] In treatment planning for patients with unilateral condylar hyperplasia, it is important to differentiate the active phase from the inactive phase.[10] When growth ceases a corrective osteotomy can be performed. In a case of persistent growth and progressive facial asymmetry the hyperactive condyle may be removed.[11,12]

Bone scintigraphy has been used in the diagnosis and treatment planning of mandibular condylar hyperplasia for a number of years.[11] This method of imaging has the ability to detect abnormalities at an early stage often before morphological changes are evident.[13] Single-photon emission computed tomography (SPECT), which measures the uptake of a radioisotope, provides a sensitive and accurate record of bone activity in the condyles of growing and non-growing patients.[14] Differences in activity between normal and abnormal condyles reflect the relative growth rates at the time of investigation, but cannot tell us how long growth will continue.[15]

A method of analysis reflecting the dynamics of condylar growth would be a valuable diagnostic tool for patients with asymmetric mandibular deformities. This study was designed to determine the radioisotope uptake by the right and left condyles in normal patients, and to calculate side-to-side percentage differences.

Material and methods

Thirty eight patients (19 males, 19 females) without facial asymmetry who were undergoing $Tc^{99}m$-MDP scintigraphy for a variety of skeletal conditions agreed to participate in this study, after an explanation that the radiation dose is dependent on the injected isotope and not on the method of scanning. The age range of the patients was 13 years to 34 years. Following a routine clinical examination all patients were considered to have normal TMJs. The patients also consented to a panoramic radiograph to rule out abnormally shaped condylar heads.

All planar and SPECT imagings were carried out using a single head Genesys SPECT system (ADAC Philips, Eindhoven, The Netherlands) three hours after injection of 25 mci $Tc^{99}m$. The SPECT system collected data over 360 degrees in a spherical field of rotation, using a 128 x 128 matrix, 64 frames at 30 seconds/frame. Coronal views, reconstructed from axial images, were summated to form a composite image. The region of interest was drawn around each TMJ, which was easily identified because of the prominent uptake of isotope. The counts were noted within this area and the relative uptake calculated as follows:

$$\text{Uptake in the right condyle} = \frac{\textit{Right counts}}{\textit{Left} + \textit{Right counts}} \times 100 \text{ per cent}$$

Differences in activity between right and left TMJs were also calculated and tested for statistical significance with the paired *t*-test. SPSS software was used for data analysis. Duplicate readings were not undertaken.

Results

The results given in Tables I and II show that the maximum differences between the percentage uptake of right and left condyles was 6.2 per cent in the male patients (Right side versus Left side: 53.1 per cent and 46.9 per cent respectively) and 5.7 per cent in the female patients (Right side versus Left side: 52.85 per cent and 47.15 per cent respectively). The mean difference between the percentage uptake of right and left condyles was 2.1 per cent (SD: 1.69). There was no significant right–left percentage difference between between the female and male groups (p = 0.85). The range for left–right side condylar uptake was 89–113 per cent (SD: 6.4).

Table II. Side-to-side differences in condylar activity.

Side-to-side differences (Per cent)	Female		Male		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
0–1	4	21	3	16	7	18.5
1–2	4	21	4	21	8	21
2–3	4	21	3	16	7	18.5
3–4	2	11	5	26	7	18.5
4–5	1	5	3	16	7	10.5
>5	4	21	1	5	4	13
	N = 19 Mean = 2.75 SD =1.79		N = 19 Mean = 2.65 SD = 1.63		N = 38 Mean = 2.1 SD = 1.69	

Discussion

It would appear that activity in the condylar heads is not equal in patients with normal TMJs.[16] It is assumed that, in the absence of any other pathological process, the difference in activity is due to variations in growth and remodelling within the condylar tissues and/or methodological causes.

Our finding that the maximum side-to-side difference in uptake of isotope of 6 per cent is similar to the 6 and 12 per cent differences reported by others.[14–16] For example, Pogrel and coworkers[16] reported that the side-to-side variations in uptake were always less then 10 per cent and Hodder and coworkers[14] reported a difference of 6 per cent between two normal condyles (Right side, Left side: 47 per cent, 53 per cent). The ratio of left–right side activity in our study is similar to that reported by Rabinson and coworkers.[15] They reported a 12 per cent variation in activity between sides.

This study determined the normal index of condylar activity in individuals with healthy joints and ruled out the effect of a genetic background on condylar activity. A previous study has shown that it has a similar range in different populations.[14–16] Interfering

Table I. Condylar uptakes in normal male and female individuals.

Case	Left–Right ratio (Per cent)	Right–Left difference (Per cent)	Mean (Per cent)		Mean counts (Counts per pixel)		Sex	Age (Years)
			Left	Right	Left	Right		
1	105.82	2.82	51.41	48.59	656.4	620.3	F	35
2	112.09	5.70	52.85	47.15	577.4	515.1	F	35
3	103.14	1.54	50.77	49.23	315.8	306.2	F	12
4	98.28	0.86	49.57	50.43	354.0	360.2	F	13
5	103.99	1.96	50.98	49.02	969.2	932.0	F	14
6	95.84	2.12	48.94	51.06	426.3	444.8	F	12
7	90.02	5.26	47.37	52.63	339.0	376.6	F	26
8	102.76	1.36	50.68	49.32	298.2	290.2	F	21
9	99.09	0.46	49.77	50.23	809.1	816.5	F	13
10	95.26	2.42	48.79	51.21	813.1	853.6	F	15
11	107.49	3.62	51.81	48.19	526.6	489.9	F	12
12	94.29	2.94	48.53	51.47	308.7	327.4	F	22
13	103.85	1.88	50.94	49.06	428.6	412.7	F	20
14	93.48	3.38	48.31	51.69	418.6	447.8	F	21
15	92.03	4.16	47.92	52.08	496.2	539.2	F	28
16	89.34	5.62	47.19	52.81	219.6	245.8	F	20
17	99.39	0.30	49.85	50.15	212.3	213.6	F	30
18	111.36	5.38	52.69	47.31	287.2	257.9	F	31
19	98.75	0.62	49.69	50.31	387.3	392.2	F	12
20	96.82	1.62	49.19	50.81	523.9	541.1	M	14
21	98.95	0.52	49.74	50.26	244.5	247.1	M	16
22	93.02	3.62	48.19	51.81	293.2	315.2	M	18
23	104.91	2.40	51.20	48.80	371.5	354.1	M	19
24	97.75	1.14	49.43	50.57	338.9	346.7	M	23
25	100.17	0.08	50.04	49.96	407.5	406.8	M	23
26	105.45	2.66	51.33	48.67	458.2	434.5	M	17
27	110.32	4.90	52.45	47.55	645.8	585.4	M	14
28	107.70	3.70	51.85	48.15	586.2	544.3	M	12
29	93.88	3.16	48.42	51.58	473.7	504.6	M	12
30	95.48	2.32	48.84	51.16	348.7	365.2	M	33
31	93.55	3.34	48.33	51.67	284.3	303.9	M	20
32	106.50	3.17	51.57	48.43	381.9	358.6	M	19
33	96.80	1.62	49.19	50.81	305.9	316.0	M	24
34	103.17	1.56	50.78	49.22	397.1	384.9	M	27
35	108.65	4.14	52.07	47.93	518.7	477.4	M	11
36	113.21	6.20	53.10	46.90	345.9	313.5	M	25
37	99.66	0.18	49.91	50.09	347.9	349.1	M	23
38	108.72	4.18	52.09	47.91	554.4	509.9	M	17

variables on condylar uptakes were excluded by a thorough TMJ examination and radiographic assessment during case selection. We reduced the errors likely to arise from selection of the middle cut for calculation of the count per pixel by summing the coronal images to form a composite image.

Two factors may influence our assumptions of condylar activity. The first is the mediolateral width of the condyles: a joint with an increased width will result in an increased count per pixel, although the joint may have normal activity. The second point in the determination of a normal index is to exclude patients in an inactive or 'burned out' phase when the side-to-side uptake of isotope can be within the normal range. Thus, the clinical status must be considered when assessing a difference in condylar uptake.

SPECT bone scintigraphy provides an accurate and quantifiable assessment of the relative activity in the mandibular condyles. Determination of the growth activity in the condylar heads allows the diagnosis of an abnormal situation to be made early and the appropriate treatment initiated.

Conclusion

Right–left differences in uptake of isotope of up to 6 per cent (Right side, Left side: 53 per cent, 47 per cent) appear to be normal.

This quantitative information can be used in the diagnosis of patients with unilateral condylar hyperplasia, and to distinguish an active phase from an inactive phase of unilateral condylar hyperplasia.

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